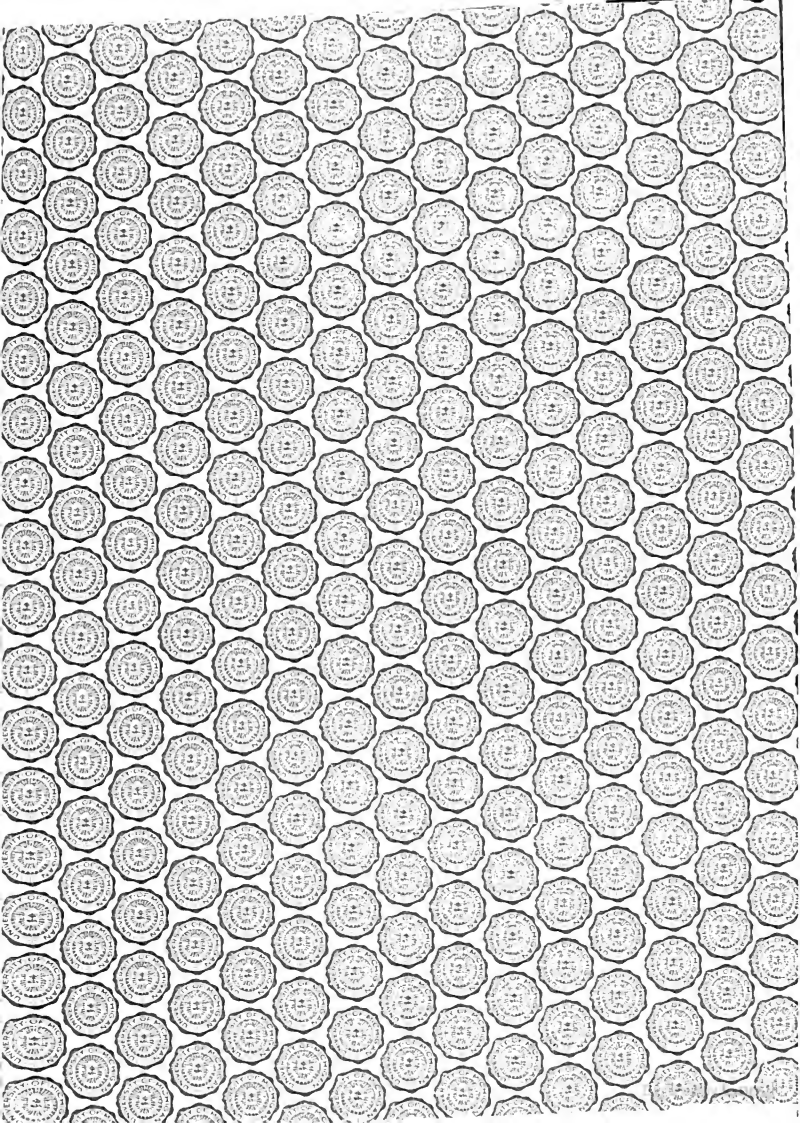
UNIVERSITY of MICHIGAN
GENERAL LIBRARY
OCTAVIA WILLIAMS BATES
BEQUEST



Museum
QE
756
.I4
A4

JAN

QE 75 .I A

# MEMOIRS

OF

# THE GEOLOGICAL SURVEY OF INDIA.

India Geological

# Palaeontologia Indica,

BEING

FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR GENERAL OF INDIA IN COUNCIL.

---

## Ser. XV.

## HIMALÁYAN FOSSILS.

## Vol. I, Part 4.

## THE PERMIAN FOSSILS OF THE PRODUCTUS SHALES OF KUMAON AND GURHWAL.

By **CARL DIENER, Ph.D.,**
*University of Vienna.*

Plates I—V.

---

CALCUTTA:
SOLD AT THE
GEOLOGICAL SURVEY OFFICE.
LONDON: KEGAN PAUL, TRENCH, TRÜBNER & CO.

MDCCCXCVII.

PRINTED BY THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA, 8, HASTINGS STREET, CALCUTTA.

# MEMOIRS OF THE GEOLOGICAL SURVEY OF INDIA.

VOL. I. Royal 8vo, pp. 309, 1859 (*out of print*). Pt. 1, 1856 (*price* 1 Re.): Preliminary notice on the Coal and Iron of Talchir.—On the geological structure and relations of the Talchir Coal-field.—Gold-yielding deposits of Upper Assam.—On specimens of gold and gold dust from Shue-gween. Pt. 2, 1858 (*price* 2 Rs.): On the geological structure of a portion of the Khasi Hills.—On the geological structure of the Nilghiri Hills (Madras). Pt. 3, 1859 (*price* 2 Rs.): On the geological structure and physical features of the Districts of Bankura, Midnapore, and Orissa.—On the laterite of Orissa.—On some fossil fish-teeth of the genus Ceratodus, from Maledi, south of Nagpur.

VOL. II. Royal 8vo, pp. 341, 1859 (*out of print*). Pt. 1, 1860 (*price* 2 Rs.): On the Vindhyan Rocks, and their associates in Bundelkand. Pt. 2, 1860 (*price* 3 Rs.): On the geological structure of the central portion of the Nerbudda District.—On the tertiary and alluvial deposits of the central portion of the Nerbudda Valley.—On the geological relations and probable geological age of the several systems of rocks in Central India and Bengal.

VOL. III. Royal 8vo, pp. 438. Pt. 1, 1863 (*price* 3 Rs.) (*out of print*). On the geological structure and relations of the Raniganj Coal-field.—Additional Remarks on the geological relations and probable geological age of the several systems of rocks in Central India and Bengal.—Indian Mineral Statistics, I. Coal. Pt. 2, 1864 (*price* 2 Rs.): On the Sub-Himalayan Ranges between the Ganges and Ravi.

VOL. IV. Royal 8vo, pp. 450. Pt. 1, 1863 (*price* 2 Rs.). Report on the Cretaceous Rocks of Trichinopoly District, Madras. Pt. 2, 1864 (*price* 2 Rs.): (*out of print*). On the structure of the Districts of Trichinopoly, Salem, etc. Pt. 3, 1865 (*price* 1 Re.): On the Coal of Assam, etc.

VOL. V. Royal 8vo, pp. 354. Pt. 1, 1865 (*price* 3 Rs.) (*out of print*). Sections across N.-W. Himálaya, from Sutlej to Indus.—On the Gypsum of Spiti. Pt. 2, 1866 (*price* 1 Re.): On the Geology of Bombay. Pt. 3, 1866 (*price* 1 Re.) (*out of print*). On the Jherria Coal-field.—Geological Observations on Western Tibet.

VOL. VI. Royal 8vo, pp. 395. Pt. 1, 1867 (*price* 8 As.): On the Neighbourhood of Lynyan, etc., in Sind.—Geology of a Portion of Cutch. Pt. 2, 1867 (*price* 2 Rs.) (*out of print*): Bokaro Coal-field.—Rámgarh Coal-field.—Traps of Western and Central India. Pt. 3, 1869 (*price* 2 Rs. 8 As.): Tapti and Nerbudda Valleys.—Frog-beds in Bombay.—*Oxyglossus pusillus.*

VOL. VII. Royal 8vo, pp. 342. Pt. 1, 1869 (*price* 3 Rs.): Vindhyan Series.—Mineral Statistics.—Coal.—Shillong Plateau. Pt. 2, 1870 (*price* 1 Re.): Karharbári Coal-field.—Deoghar Coal-field. Pt. 3, 1871 (*price* 1 Re.): Aden Water-supply.—Káranpura Coal-fields.

VOL. VIII. Royal 8vo, pp. 353. Pt. 1, 1872 (*price* 4 Rs.): On the Kadapah and Karnul Formations in the Madras Presidency. Pt. 2, 1872 (*price* 1 Re.): Itkhuri Coal-field.—Daltonganj Coal-field.—Chope Coal-field.

VOL. IX. Royal 8vo, pp. iv, 358. Pt. 1, 1872 (*price* 4 Rs.): Geology of Kutch. Pt. 2, 1872 (*price* 1 Re.): Geology of Nagpur.—Geology of Sirban Hill.—Carboniferous Ammonites, pp. 65.

VOL. X. Royal 8vo, pp. 359. Pt. 1 (*price* 3 Rs.): Geology of Madras.—Sátpura Coal-basin. Pt. 2, 1874 (*price* 2 Rs.): Geology of Pegu.

VOL. XI. Royal 8vo, pp. 338. Pt. 1, 1874 (*price* 2 Rs.): Geology of Dárjiling and Western Duars. Pt. 2, 1876 (*price* 3 Rs.): Salt-region of Kohát, Trans-Indus.

VOL. XII. Royal 8vo, pp. 363. Pt. 1, 1877 (*price* 3 Rs.): South Mahrátta Country. Pt. 2, 1876 (*price* 2 Rs.): Coal-fields of the Nága Hills.

VOL. XIII. Royal 8vo, pp. 248. Pt. 1, 1877 (*price* 2 Rs. 8 As.): Wardha Valley Coal-field. Pt. 2, 1877 (*price* 2 Rs. 8 As.): Geology of the Rájmahál Hills.

VOL. XIV. Royal 8vo, pp. 313, 1878. Geology of the Salt-range in the Punjab.

VOL. XV. Royal 8vo, pp. 192. Pt. 1, 1878 (*price* 2 Rs. 8 As.): Geology of the Auranga and Hutár Coal-fields (Palamow). Pt. 2, 1880 (*price* 2 Rs. 8 As.): Ramkola and Tatapani Coal-fields (Sirguja).

VOL. XVI. Royal 8vo, pp. 264. Pt. 1, 1879 (*price* 1 Re. 8 As.): Geology of Eastern Coast from Lat. 15° to Masulipatam. Pt. 2, 1880 (*price* 1 Re. 8 As.) The Nellore Portion of the Carnatic. Pt. 3, 1880 (*price* 2 Rs.): Coastal region of the Godávari District.

VOL. XVII. Royal 8vo, pp. 305. Pt. 1, 1879 (*price* 3 Rs.): Geology of Western Sind. Pt. 2, 1880 (*price* 3 Rs.): Trans-Indus extension of the Punjab Salt-range.

VOL. XVIII. Royal 8vo, pp. 300. Pt. 1, 1881 (*price* 2 Rs.): Southern Afghanistan. Pt. 2, 1881 (*price* 1 Re. 8 As.) (*out of print*): Mánbhum and Singhbhum. Pt. 3, 1881 (*price* 2 Rs.): Pranhita-Godavari Valley.

VOL. XIX. Royal 8vo, pp. 242. Pt. 1, 1882 (*price* 2 Rs.): The Cachar Earthquake of 1869. Pt. 2, 1882 (*price* 1 Re.) Thermal springs of India. Pt. 3, 1883 (*price* 1 Re.): A catalogue of Indian Earthquakes. Pt. 4, 1883 (*price* 1 Re.): Geology of parts of Manipur and the Nága Hills.

VOL. XX. Royal 8vo, pp. 240, Pt. 1, 1883 (*price* 2 Rs. 8 As.): Geology of Madura and Tinnevelly. Pt. 2, 1883 (*price* 2 Rs. 8 As.): Geological notes on the hills in the neighbourhood of the Sind and Punjab Frontier between Quetta and Dera Ghazi Khan.

VOL. XXI. Royal 8vo, pp. 286 (*out of print*). Pt. 1, 1884 (*price* 2 Rs.): Geology of the Lower Narbudda Valley. Pt. 2, 1884 (*price* 1 Re.): Geology of Kathiawar. Pt. 3, 1885 (*price* 2 Rs.): Coal-field of South Rewah. Pt. 4, 1885 (*price* 1 Re.): Barren Island.

VOL. XXII. Royal 8vo, pp. 344, 1883. The Geology of Kashmir, Chamba, and Khagan.

VOL. XXIII. Royal 8vo, pp. 232, 1891. Geology of the Central Himálayas.

VOL. XXIV. Royal 8vo, Pt 1, 1887 (*price* 1 Re. 8 As.): The Southern Coal-fields of the Sátpura Gondwána Basin. Pt. 2. 1890 (*price* 2 Rs. 4 As.): Physical Geology of the Sub-Himálaya of Garhwál and Kumaun. Pt. 3, 1890 (*price* 1 Re. 4 As.): Geology of South Malabar, between the Beypore and Ponnáni Rivers.

VOL. XXV. Royal 8vo. Geology of the Bellary District, Madras Presidency.

VOL. XXVI. Royal 8vo. Geology of Hazara.

VOL. XXVII Royal 8vo. Part 1, 1895 (price 1 Re.): Marine Fossils from the Miocene of Upper Burma.

---

The price fixed for these publications is 5 Rs. (10s.) each volume.

# HIMALAYAN FOSSILS.

## Vol. I, Part 4.

# THE PERMIAN FOSSILS OF THE PRODUCTUS SHALES OF KUMAON AND GURHWAL.

Museum
Bate

# HIMÁLAYAN FOSSILS.

## VOLUME I, PART 4.

# THE PERMIAN FOSSILS OF THE PRODUCTUS SHALES OF KUMAON AND GURHWAL.

BY

D. CARL DIENER, PH. D.

WITH PLATES I—IV.

## INTRODUCTION.

The name *Productus shales* has been assigned by Mr. C. L. Griesbach[1] to the dark, friable shales, which in the Niti area are intimately connected with the lowest triassic deposits, the Otoceras beds, but contain a palæozoic fauna "chiefly *Producti* of latest carboniferous or permian type."

The sections, where this horizon has been most carefully studied, and is richest in fossils, are those between Kiunglung encamping ground at the head waters of the Dhauli Ganga and the Niti Pass (16,628 feet).

On the southern slope of the Niti Pass a normal sequence of carboniferous beds is exposed at the base of the Productus shales. The upper division of the carboniferous system is formed by a white quartzite of about 350 feet in thickness. The boundary between this dazzling white quartzite and the black, often carbonaceous Productus shales is one of the most important landmarks in the structure of the Central Himálayas. In some other places of the Niti area, however, the carboniferous strata have suffered a certain amount of denudation before the Productus shales were deposited. It has been stated by Griesbach that the upper boundary of the white quartzite often exhibits a rugged and denuded surface and that it is even completely wanting near Patalpani, where the Productus shales rest unconformably on the lower divisions of the carboniferous system.[2]

While the Productus shales are sharply and abruptly defined at their base, partially overlapping, as is supposed by Mr. Griesbach, an eroded surface of upper carboniferous, they pass quite gradually into the lower trias without the slightest trace of unconformity.

---

[1] *C. L. Griesbach*,—Geology of the Central Himálayas. Mem. Geol. Surv. of India, Vol. XXIII, 1891, p. 66.

[2] l. c. p. 114—117.

The lithological character of the Productus shales is described by Griesbach (l. c. p. 66) as follows:—

"Generally resting on the white quartzite of the upper carboniferous it sharply contrasts with the latter; consists of very dark, occasionally micaceous shales, exceedingly friable and crumbling into an earthy dark mass. The shales may be said to be earthy here and there, with coaly traces—carbonized vegetable matter. A few irregular partings of hard ferruginous sandstone divide the thickness of the shales, an occasional string of nodular clay iron ore is found in place of such sandstone partings. In lithological character these shales differ so little from the next higher horizon, that it is easy to mistake one for the other. The higher *Otoceras* beds are, however, less earthy and not micaceous. Throughout the horizon fossils are found—chiefly ***Producti*** of latest carboniferous or permian type. The best preserved specimens are contained in the grey sandstone partings which are often crowded with *Producti.*"

Nearly all the fossils of this horizon, which have been collected by Mr. C. L. Griesbach in the Niti area, are marked on his labels as coming from the southern slope of the Niti Pass, between this latter and Kiunglung encamping ground. These fossils, chiefly brachiopods, are enclosed in a dark, grey micaceous sandstone, the weathered portions of which often exhibit a bright red or yellow colour. Some rock-specimens are true lumachellæ, made up entirely of the casts of ***Chonetes Vishnu Spirigerella Derbyi, Athyris Royssii*** or ***Productus cancriniformis.*** Most of the ***Productidæ*** are, unfortunately, rather poorly preserved. They are only casts, portions of the shell having been very rarely preserved, nor have I been able to study their internal structure, except in two cases (***Productus Purdoni*** and ***Productus gangeticus***).

From this locality I have to mention the following species[1]:—

*Productus gangeticus*. nov. sp., C.
,, *Purdoni*, Dav., R.
,, *cf. Cancrini*, Vern., VR.
,, *cf. serialis*, Waagen, VR.
,, *cancriniformis*, Tschern., VC.
*Chonetes Vishnu*, Salt., VC.
*Spirifer musakheylensis*, Dav., C.
,, *sp. aff. fascigero*, Keys., VR.
,, *nitiensis*, n. sp., R.
,, *Ravana*, n. sp., VR.
,, *sp. ind.*
*Martinia glabra*, Mart. sp., R.
*Athyris Royssii*, Lev. sp., VC.
*Spirigerella Derbyi*, Waag., VC.
*Dielasma*, sp., ind.
*Aviculopecten hiemalis*, Salt., C.

The next locality (in south-eastern direction), from which fossils of this horizon have been mentioned, is the Chorhoti Pass (leading from Niti to Rimkin Paiar encamping ground). The fossils, which were collected by General R. Strachey and afterwards described by J. W. Salter[1] as carboniferous, were found in loose blocks, in a locality filled with silurian slate. General Strachey, however, stated that the whole series of rocks was traversed by great faults, some of which may probably have brought down those younger strata from a higher level. The species described by Salter, were collected from a blackish, arenaceous limestone. As they are the only ones in the Niti area, to which this author attributed a carboniferous age, it seems worth mentioning, that no true carboniferous deposits have been made known by Strachey.

---

[1] The signs applied in this and the following lists are as follows:— VR = very rare; R = rare; C = common, VC = very common.

J. W. Salter gives the following list (p. 52) of species from this locality :—

1. *Productus Purdoni*, Dav. Pl. V, fig. 10.
2. *P. Flemingi*, Sow. ? (or *P. carbonarius* de Kon.) Pl. V, fig. 11.
3. *Chonetes Vishnu*, Salter.
4. *Athyris Royssii*, Lev. (only a small variety but pretty plentiful here) Pl. V, fig. 13.
5. *Orthis*, sp.
6. *Aviculopecten hiemalis*, Salter. Pl. V, fig. 14.

As only the two new species have been fully described by Salter, while the rest have been only figured in a rather insufficient manner, it is not easy to identify them with my material.

There can be but little doubt about *Athyris Royssii*, which is most probably present among the fossils of the Productus shales from the Chorhoti. What has been figured by Salter as *Productus Purdoni*, is a fragment of the dorsal valve of either *Productus gangeticus* or of *P. serialis*, Waag., but has, I believe, nothing to do with Davidson's species. Salter's *Productus Flemingi* or *P. carbonarius* can scarcely be identical with *P. cancriniformis*, Tschern., although it is apparently provided with a similar sculpture. The shape of the apical region however recalls that of a *Chonetes*. In this respect the figure (Pl. V. fig. 11) is entirely misleading, as it represents a brachiopod with a distinct area, but not a species of the genus *Productus*. I am consequently unable to identify this species with any in the Himálayan collection.

The *Orthis* (?) may perhaps have to be considered as the dorsal valve of *Chonetes Vishnu*, which seems to have remained unknown to Salter and may, especially in incomplete fragments, be easily mistaken for an *Orthis*.

Nevertheless the character of this fauna leaves no doubt as to its derivation from the permian Productus shales of Painkhánda.

On the southern slopes of the Shalshal Cliff near Rimkin Paiar encamping ground and of the Bambanag range in the Girthi valley I had myself an opportunity of studying the lithological and stratigraphical features of the Productus shales. I found them—in perfect accordance with Griesbach's description—developed as shining black, splintery shales, showing considerable resemblance to the well known Spiti shales. Like the latter they contain many concretions, which, however, are always devoid of fossils. In the sections examined by myself the Productus shales proved to be entirely unfossiliferous. There is indeed no fossil from any locality between the Niti Pass and Lissar valley represented in the Himálayan collection.

---

[1] *J. W. Salter* and *H. F. Blanford*,—Palæontology of Niti in the Northern Himálaya: being descriptions and figures of the palæozoic and secondary fossils, collected by Colonel Richard Strachey. Calcutta, 1865, p. 52.

In the valleys of the Lissar Ganga and Dharma Ganga the Productus shales are quoted by C. L. Griesbach (*loc. cit.* p. 172—178) in many of his sections. They are here rather thicker than in the Painkhánda sections, especially in the section described on page 175, where the Productus shales are both strongly developed and rich in fossils. Part of this section runs as follows :—

| | |
|---|---|
| *Lower trias* | Dark limestone in thin beds, with dark shales alternating; fossils of the *Otoceras* stage. |
| *Productus shales* (Total thickness about 185 feet). | *i.* Black crumbling shales, with ferruginous concretions in irregular partings, thickness 85 feet. |
| | *h.* Micaceous and calcareous sandstone with *fucoid* markings; with shaly partings and irregular thickness about 2 feet. |
| | *g.* Micaceous dark shales, which weather in bright colours with ferruginous concretions. Shales show *fucoid* markings. Thickness 7 feet. |
| | *f.* Same as *h.* With *brachiopods.* Thickness 3 feet. |
| | *e.* Same as *g.* Thickness 51 feet. |
| | *d.* Dark limestone with indistinct *plant* remains, thickness 8 inches. |
| | *c.* Dark micaceous shales with *fucoid* impressions. Thickness 26 feet. |
| | *b.* Argillaceous limestone in thicker beds, thickness 8 feet. |
| | *a.* Earthy shales with *fucoid* impressions. Thickness 3 feet. |
| *Upper carboniferous* ... | White quartzite series. |

Bed *f* is very rich in brachiopods. To judge from the rock specimens in the Himálayan collection it must be a true lumachella, resembling most closely similar lumachellæ in the sandstone partings of the Productus shales near Kiunglung encamping ground, as above described. But the association of species is somewhat different, as bed *f* is made up almost entirely of the casts of *Chonetes lissarensis.*

The list of species represented in the Productus shales of the Lissar valley is very small in comparison with the enormous number of individuals. I have to mention the following species only :—

*Chonetes lissarensis*, nov. sp.
*Spirifer Ravana*, nov. sp.
" *musakheylensis*, Dav.
" *joharensis*, nov. sp.
*Athyris Royssii*, Lev.
*Productus*, sp. ind.

It is rather remarkable, that not a single specimen of *Productus cancriniformis* or *Spirigerella Derbyi* has been collected in the Productus shales of the Lissar valley, whereas these two species are exceedingly common in the same beds of the Niti area.

From the Mankshang pass at the head of the Kuti Yangti valley one single fossil of this horizon only is present in Griesbach's collection. It is the ***Orthoceras*** figured on Pl. V of this memoir.

That equivalents of the Productus shales are equally present in Spiti, has been proved by Griesbach with full certainty. Here they form part of Stoliczka's Kuling shales, but, as has been justly remarked by Griesbach, beds of a very different age have been united by Stoliczka as Kuling Shales, to which horizon this author has assigned a carboniferous age.[1] Some of the more instructive sections through the carboniferous and permian deposits of Spiti have been more fully described by C. L. Griesbach in his monograph on the Central Himálayas (p. 215–223). The divisions of the two systems in Spiti are the following (according to Griesbach's table) :—

9. Black ***Productus*** (Kuling) Shales.
8*a*. Dark flaggy limestone.
8. White quartzite series (Muth Quartzite).
7*a*. Red crinoid Limestone.
7. Earthy dark-grey limestone.

The flaggy limestone 8*a*. is wanting in all the eastern sections. It conformably overlies the white quartzite of an upper carboniferous age in flaggy beds of a total thickness of about 70 feet. According to Griesbach (l. c. p. 216) it "has yielded numerous fossils, though few in species. Amongst them are several ***Producti, Athyris Royssii*** and ***Corals***. Its evident connection with the white quartzite (8) and fossils define its upper carboniferous age."

The Productus shales, which in the Spiti sections seem to rest conformably on the carboniferous beds, are described by Griesbach (l. c. p. 218) as "150 to 200 feet in thickness, mostly densely black, crumbling and soft, divided by strings of ferruginous concretions and layers of splintery shales. Occasionally an irregular bed of dark grey to olive coloured sandstone, weathering dark brown, divides the formation and is generally full of fossils, chiefly ***Producti***. The shales also yielded many specimens of ***Producti*** and a few other brachiopods."

I have intentionally quoted Griesbach's description in full detail, because it is very important, proving the existence of two neighbouring fossiliferous horizons, one of which is supposed to be of upper carboniferous age, whereas the other must be an equivalent of the permian Productus shales of Gurhwal and Kumaon. Unfortunately the fossils from these two horizons seem not to have been kept separate in the Himálayan collection. Griesbach's collection from the localities of Muth, Khar and Kuling in Spiti contains the following species only :—

***Marginifera aff. typica***, Waag.
***Spirifer rajah***, Salter.
,, ***musakheylensis***, Dav.

---

[1] F *Stoliczka* : "Geological sections across the Himalayan Mountains from Wangtu Bridge on the River Sutlej to Sungdo on the Indus." Mem. Geol. Surv. of India, V. Pt. I. Calcutta, 1865, p. 24.

Among them *Marginifera aff. typica* is by far the most common fossil. A very large number of specimens is present in Griesbach's collection as well as in the collections of Drs. Gerard and Stoliczka. It is the same species, which the latter author has identified with ***Productus semireticulatus*** Mart. and with ***P. longispinus***, Sow.[1] and it is probably likewise identical with Lydekker's ***Productus semireticulatus*** from the Kuling series of the Kashmir Valley.[2] Neither this species nor ***Spirifer rajah*** is as yet known from the Productus shales of Gurhwal and Kumaon of truly permian age. The third species, ***Spirifer musakheylensis***, Dav., is an ubiquitous species in the Indian region, ranging in the Productus limestone of the Salt Range from the lowest to the topmost bed. These fossils therefore do not afford any clue as to the age of the strata, from which they have been derived. Nor can any conclusion be drawn from the labels attached to them, which simply mark their horizon as "Upper carboniferous."

The matter becomes still more complicated by an inspection of the large bulk of fossils, which have been collected by different observers in the so-called carboniferous deposits of Kashmir. There can be little doubt that equivalents of the true Productus shales of Gurhwal and Kumaon must likewise be present. One of the most typical fossils of the permian strata of the Salt Range, ***Productus Abichi***, Waagen, has been figured by Lydekker,[3] (identified by him with ***P. Humboldti***, d'Orb.), and is quoted by this author as having been collected in the Kuling series of the Kashmir valley. It is, however, absolutely impossible to state, which portion of the so-called carboniferous beds of Spiti and Kashmir actually corresponds to the Productus shales. I have tried in vain to establish a division of the fossil materials contained in the Himálayan collection with regard to stratigraphical horizons. I entirely failed to succeed, because a very large percentage of the predominating brachiopods are common to the permian and carboniferous rocks.

Consequently, I at last resolved to describe the fossils of the Productus shales in Gurhwal and Kumaon quite separately. This seemed to me the only way to avoid confusion. In Gurhwal and in Kumaon the Productus shales are a well established horizon with a distinct fauna. In other parts also of the Himálayas, however, this horizon is, it is true, certainly present, but the geological reconnaissances have not been carried out carefully and thoroughly enough up to now, to allow a special description of its fauna. It is therefore impossible for the moment, as I at first desired, to unite the description of all the permian fossils of the Himálayas in one part of this volume, as in the collections from Kashmir and Spiti the carboniferous and permian faunas cannot be separated with precision. On the other hand it would have been a pity not to devote a special description to the permian fauna of the eastern portion of the Central Himálayas, where this fauna is imbedded in a horizon with a distinctly fixed stratigraphical character. The treating of fossils, belonging probably to the same horizon, in different parts of this volume may be felt as inconvenient, but it was, I believe, the only way to remain on safe ground.

---

[1] cf. *Stoliczka*, l. c. p. 29.

[2] *R. Lydekker*, "The Geology of the Kashmir and Chámba Territories, and the British district of Khágán." Mem. Geol. Surv. of India, XXII., Calcutta, 1883, Pl. II, fig. 2.

[3] *R. Lydekker*, l. c. Pl. II, fig. 3.

In finishing the introduction to this memoir it is my duty to express my sincere thanks to all those, who have contributed more or less materially to its completion.

Among them I have to offer my most sincere gratitude to Professor W. Waagen, whose amiable advice aided me in many ways, and has been of no small influence on the contents of this memoir.

Great thanks I owe to Dr. Theodor Fuchs, Director of the Geological Department of the Imperial Museum of Natural History in Vienna, who kindly furnished me with all the materials from the permocarboniferous rocks of Spitzbergen in the possession of his department, for comparison and description. He thus enabled me to study a considerable number of Toula's type specimens from Payer's, Höfer's and Drasche's collections. The presence of Himálayan species (***Spirifer musakheylensis***) in Spitzbergen, or their close relationship to Spitzbergen forms (***Productus Payeri***) would otherwise have remained unknown.

To Professor E. Suess I am indebted for the unlimited loan and use of specimens, contained in the university's Geological Museum, to Professor Th. Tschernyschew of St. Petersburg for his kind assistance in determining some of my Himálayan specimens of ***Productus***.

My most sincere thanks are due to the Director of the Geological Survey of India, who with this as with my foregoing memoirs undertook the unpleasant task of reading the proofs.

# DESCRIPTION OF FOSSILS.

## MOLLUSCA.

### Class: CEPHALOPODA.

### Order: NAUTILOIDEA.

### Family: *ORTHOCERATIDÆ.*

### Genus: ORTHOCERAS, Breynius.

ORTHOCERAS SP. IND. Pl. V., fig. 12.

The single, rather poorly preserved, specimen of *Orthoceras* in the Himálayan collection of Productus shales fossils belongs to the section of the *Orthocerata striata*.

The distance of two septa is exactly half the diameter of the lower septum. The specimen has been so considerably deformed, that I cannot make out the exact shape of its transverse section. I believe it however to be circular, not elliptical. The central position of the siphuncle, as indicated in the drawing, is equally doubtful. The body chamber is partly preserved. The angle of emergence seems to be remarkably small. I estimate it to be about 4 degrees only.

The fragments of the shell are covered with numerous delicate striæ without any distinct imbrication. About ten striæ are counted on the surface of the lowest chamber (diameter about 14 millimeters), corresponding to a distance between the two septa of 5 mm.

Among the carboniferous species of the genus *Orthoceras* described by L. de Koninck, there is not a single one which might advantageously be compared with the present specimen. Although, in general, the latter rather recalls the triassic species of *Orthoceras*, its state of preservation is too bad, to fix any of its affinities in a more positive way, as neither the outlines of its transverse section nor the position of its siphuncle are exactly known.

*Locality, number of specimens examined.*—Mankshang Pass, Kuti Yangti valley, Byans, 1.

# Class: LAMELLIBRANCHIATA.

## Order: ANISOMYARIA, Neumayr.

## Family: *PECTINIDÆ*, Lam.

### Genus: AVICULOPECTEN, M'Coy.

**AVICULOPECTEN HIEMALIS**, Salter. Pl. V, fig. 10 a, b, 11.

1865. *Aviculopecten hiemalis*, Salter. Palæontology of Niti in the Northern Himálayas, etc., by J. W. Salter and H. F. Blanford, Calcutta, p. 55. Pl. V, fig. 14.

1881. *Aviculopecten hiemalis*, Waagen. Salt Range Fossils. Palæontologia Indica, ser. xiii. Vol. I, Productus limestone Fossils p. 301.

As I have not been able to clear the hinge apparatus from the adhering matrix in any of the specimens from the Himálayan collection, the generic determination of this species is founded on its external characters only. Among the *Pectinidæ* of the Salt Range Productus limestone Waagen, as a rule, considers as belonging to the genus *Aviculopecten* such species as have the anterior wing smaller than the posterior one, whilst on the contrary the species with a large anterior and a small posterior wing were attributed by him to the true genus *Pecten*.

Salter, when introducing his new species, had only a left valve available for description. In my material the species is likewise represented by left valves only having the anterior wing, considerably smaller than the posterior one. Although this fact seems to exclude the ascription of the present species to the genus *Pecten* Klein, there still remains the difficulty to be settled, to which of M'Coy's nearly allied genera, *Aviculopecten* or *Streblopteria*,[1] it ought to be attributed. The great difficulties encountered in settling the limits of these two genera, are well displayed in Salomon's memoir: "Geologische und Palæontologische Studien über die Marmolata" (Palæontographica, XLII, 1895, p. 149). The only character, which always holds good for their distinction, is the inequality of the two valves in *Aviculopecten*. In the face of the absence of the second valve one is at a loss how to distinguish the single valves.

After many fruitless attempts I at last succeeded in clearing the apical region of a right valve from the adhering rock. This latter, although very poorly preserved, proves the two valves to be markedly unequal. Thus the reference of our species to the genus *Aviculopecten* seems to be thoroughly justified.

Salomon justly laid a special stress on the very slight differences existing between *Streblopteria*, which has always been considered a genuine member of the family *Pectinidæ*, and *Aviculopecten*, which is assigned by different authors either to the *Pectinidæ* or *Aviculidæ*. He consequently groups *Aviculopecten* with the

---

[1] *M'Coy*, Annals and Magazine of Natural History, VII, Ser. ii. 1851, p. 170.

*Pectinidæ*, following, as he states, the opinion expressed by K. von Zittel in his excellent "Handbuch der Palæontologie" (Band II, 1885, p. 30). It must however be mentioned, that Zittel in his recently published "Grundzüge der Palæontologie" (München und Leipzig, 1895, p. 261) takes a different view of the subject, quoting ***Aviculopecten*** among the ***Aviculidæ***, Lam., whereas ***Streblopteria*** is left, of course, with the ***Pectinidæ***. As the present one seems to me a case in which it must be left to the taste of each author, how far he is inclined to extend the limits of the one or the other family, I prefer to follow Waagen's and Salomon's views in this matter.

Salter characterises the present species in the following manner :—

"A. semiuncialis. Valva profundior convexa, subtrigona, apice acuto, auribus modicis, abrupte depressis. Superficies costis 16 eminentibus, æquidistantibus interlineatis.

"The left valve of this small species—only one half inch long and as much wide—is orbicular, regularly convex, subtriangular, and rounded in front. The beak is sharp and projecting; the ears are unequal—the anterior one small, with a few striæ; the posterior broad, notched, and pointed, and both abruptly sunk. The surface of the shell is regularly radiated by about sixteen strong sharp ribs, equally distant from each other, and interlined regularly by a finer one between each pair."

"The ribs are nearly smooth, a little nodular here and there, and crossed by concentric ridges of growth.

To this description of the species the following remarks may be added :—

The general outline of the shell is but very slightly inequilateral and longer than high. The left valve is tolerably inflated and, so far as I am able to judge from my apical fragment of a right valve, much more strongly vaulted than the latter. Its greatest thickness coincides with the upper quarter of the diameter, extending from the apex to the ventral margin.

The apex is about median in its position, little prominent, pointed and well incurved. It is limited on both sides by wings, which are quite distinctly marked off from the remainder of the shell. The anterior marginal edge, separating the marginal region of the shell from the corresponding wing, slopes in a perpendicular wall towards the surface of the latter. Towards the posterior wing the shell is less steeply inclined, and the edge, separating them, is less sharply defined.

The apical angle varies in my specimens from 83° to 88°, whereas the angle between the lines connecting the apex with the terminal points of the ventral shell margin is about 100°.

The anterior shell margin forms a broad curve, which projects far in front of the anterior wing and unites with the ventral margin in a strong, semicircular convexity. The posterior shell margin descends from the emargination of the wing in a very broad and flat curve, and forms an obliquely pointed arch in uniting with the ventral margin whose shape is nearly semicircular.

The anterior wing is smaller, more slender and more strongly emarginated than the posterior one. It is slightly vaulted. The length of its anterior margin is about one half the length of its sutural margin, which itself is of equal length with the hinge line of the anterior wing. Its falciform anterior margin unites with the hinge line in a sharp point. The posterior wing is considerably broader, and flat. It seems from the larger of my figured specimens, that it was pointed. There is, however, no distinct observation possible as to its exact shape, the posterior portion of this wing being broken off completely in all the rest of my specimens.

The hinge line is straight and considerably shorter than the length of the shell, measuring only two thirds of the latter. The mode of insertion of the ligament could not be observed.

With regard to the sculpture of the shell I must slightly correct Salter's diagnosis.

Three different classes of ribs may be distinguished according to their strength. The principal ribs, which rise in the apex, are only 8 in number. Between two of them one rib as a rule is regularly intercalated, which often assumes a strength equal to that of the principal ribs on approaching the ventral margin of the shell (*e.g.*, the specimen, figured Pl. V, fig. 10 a.), but either does not reach the apex at all or grows very thin in its vicinity. The ribs of the third sort are more delicate, although rather unequal in strength and size, and are placed irregularly between those of the former classes. A small number of them even develop by the bifurcation of a single rib. The principal costæ are equidistant, prominent and steeply rounded on their tops, with flatly curved valleys between them. In some of my specimens they show a marked tendency to rise into protracted nodular elevations, which are, however, only faintly defined.

The radial sculpture is crossed by numerous shelly lamellæ, corresponding to stages of growth and forming occasionally broad, ogival vaults on the radiating ribs (Pl. V, fig. 11).

The anterior wing is covered by both thin radial ribs and striæ of growth. The sculpture of the posterior wing I have not been able to study. If any exists, it ought to be very delicate.

The specimen of *A. hiemalis*, figured by Salter, is a comparatively small one. Some of the shells, collected by Griesbach at the same locality, attain a much larger size.

The measurements of the two specimens, which have been figured in the present memoir and among which the second one is the largest in my collection, are as follows:—

| | Pl. V. fig. 10. | Fig. 11. |
|---|---|---|
| Entire length of the shell . . . . . . | about 34 mm. | 51 mm. |
| " height " " " . . . . . . | 31 " | 42 " |
| Thickness of the left valve . . . . . . | 5.5 " | 9 " |
| Length of the hinge line . . . . . . | ? " | 33 " |
| Apical angle . . . . . . . . | 83° " | 87° " |

Waagen,[1] misled by Salter's bad figure, considered ***Aviculopecten crebristriatus***, Koninck,[2] from the lowest fossiliferous bed of the Salt Range Productus limestone as the nearest ally to the present species. Their resemblance is, however, only a distant one, and there is no difficulty in distinguishing the two species. Remarkable differences exist in the nearly circular outline, in the equal thickness of the two valves, and in the less prominent sculpture of *A. crebristriatus*. A further difference may be constituted by the shape of the anterior wing, which in one of Waagen's specimens seems to stretch rather far down the anterior margin of the shell, and to be limited on its upper side not by a horizontal but by a sloping hinge-line.

---

[1] Salt Range Fossils, Pal. Indica, Productus limestone Fossils, ser. xiii, I. p. 313.

[2] Quart. Journ. Geol. Soc., London, XIX, p. 8, Pl. IV, fig. 5; Mémoire sur les fossiles paléozoiques, recueillis dans l'Inde, p. 17, Pl. IV, fig. 5.

A much greater affinity than to any of the palæozoic forms from the Salt Range is exhibited by the present species to *A. Kokscharofi* Verneuil[1] from the permocarboniferous and permian strata of Russia.

There has been some confusion about *Aviculopecten Kokscharofi* and *A. Bouéi* Verneuil (Pl. XXI, fig. 6, p. 326), which was completely cleared up by Count A. von Keyserling[2] and Th. Tschernyschew.[3] In sculpture and in general outline my largest specimen of *A. hiemalis* (Pl. V, fig. 11) resembles Tschernyschew's type specimen of *A. Kokscharofi* from Soligalitsch so very closely that differences can only be noticed in the minor details. In *A. Kokscharofi* the apex seems to be more strongly pointed, but less prominent, the apical angle is larger, the anterior wing seems to be flat, not slightly vaulted, and its anterior margin is not of falciform shape as in *A. hiemalis*. All these differences are however of so small importance, that with specimens of *A. Kokscharofi* for comparison at hand, one might perhaps be compelled to consider the Indian shell to be only a variety of the Russian species. For the present I must content myself with drawing attention to the fact that the two species are apparently very nearly related to each other.

A similar sculpture to that of *A. hiemalis* and in *A. Kokscharofi* is exhibited by *A. Draschei*, Toula,[4] from the permocarboniferous strata of the western coast of Spitzbergen. The sculpture of this species is likewise distinguished by the presence of three different groups of costæ, among which the strongest only reach to the apex of the shell. Essential differences consist, however, in its perfectly rounded margin and in the shape of the wings, the posterior wing being strongly emarginate and sharply pointed.

A more distant similarity is exhibited by the sculpture of *A. occidaneus*, Meek, (Cl. King, Report of the geological exploration of the 40th parallel, Vol. IV, Washington, 1877, Palæontology, p. 96, Pl. XII, fig. 13) and of *A. hoernesianus* de Koninck (Monographie des Fossiles carbonifères de Bleiberg en Carinthie, Bruxelles, 1873, p. 89, Pl. III, fig. 27). Whether nearer affinities exist between our species and *A. ægypticus*, Walther (Ueber eine Kohlenkalk-fauna aus der ægyptisch-arabischen Wüste, Zeitschr. Deutsch Geol. Gesellsch, XLII, 1890, p. 437, Taf. XXIV, fig. 11) from the upper carboniferous strata of the Uadi el Arabah,[1] I am not able to decide. In their outlines and sculpture the two species show a marked resemblance, although Walther's figure and description do not give a very clear idea of the African form. An essential difference consists in the three rows of spines, which are observed on the anterior wing of *A. ægypticus.*

---

[1] *E. de Verneuil* in: *Murchison, de Verneuil* et *A. de Keyserling*, Géologie de la Russie de l'Europe et de Montagnes de l'Oural, 1875, Vol. II, p. 325, Pl. XX, fig. 16.

[2] *A. Graf Keyserling* und *Paul von Krusenstern*: Wissenschaftliche Beobachtungen auf einer Reise in das Petschoraland. St Petersbourg 1876, p. 275.

[3] *Th. Tschernyschew*: Der permische Kalkstein im Gouvernement Kostroma. Separatabdr. aus Verh. der kais. russ. mineral. Gesellsch. in St. Petersbourg, 1885, p. 20. See also *L. de Koninck*, Faune du calcaire carbonifère de la Belgique. Annales du Musée Royal d'Hist. nat. de Belgique, XI. 5ème partie, p. 221.

[4] *F. Toula*: Permo-Carbon-Fossilien von der Westküste von Spitzbergen. Neues Jahrb. f. Miner. 1875, p. 212. Taf. VII, fig. 5a, non b. I do not think that the latter specimen can be identified with Toula's species, as it is distinguished from it by its oblique outline and by a strong difference in the proportion of its length and height.

*Locality, number of specimens examined.*—N. W. Kiunglung encamping ground, S. W. Niti Pass, Painkhánda, 6.

*Remarks.*—*Aviculopecten hiemalis* has not been discovered outside the district of Painkhánda. Its nearest ally, *A. Kokscharofi*, is known from upper carboniferous, permocarboniferous and permian beds. As *A. hiemalis* may perhaps prove to be only a variety of this wide spread species, a few notes on the geographical and geological distribution of the latter may be found useful.

*A. Kokscharofi* was first described by E. de Verneuil from Schidrowa on the river Waga (Archangel), where it had been collected in a marly limestone overlying the strata of white gypsum, which, according to Murchison, form in this country the base of the permian system. It is quoted by Count Keyserling from the permian limestone of Kischerma on the river Wel, and by Th. Tschernyschew from the lower permian of Kostroma, from the permocarboniferous deposits of the western slope of the Ural Mountains, and (according to Barbot de Marny and Lahusen) from Kirilow. Tschernyschew in his memoir on Kostroma expressly mentions *A. Kokscharofi* among the species, which make their first appearance in the Artinsk stage, but do not descend into older strata of carboniferous age. Nikitin[2] however figures an imperfect fragment from the stage of Gshel (horizon of *Chonetes uralica*) as *A. cf. Kokscharofi* and quotes this species from the topmost carboniferous beds of the Ural, adding that it does not occur in the Moscovian stage (horizon of *Spirifer mosquensis*). Also Tschernyschew,[3] in contradiction to his first statement, later on quotes *A. Kokscharofi* from the upper carboniferous deposits of the Timan. From Spitzbergen the species has been described by F. Toula[4] as *A. Bouei.* It there occurs in strata of probably permocarboniferous age.[5]

I scarcely need to state that *Pecten hiemalis* Teller[6] has nothing to do with the present species.

---

[1] *R. Schellwien:* Ueber eine angebliche Kohlenkalk-Fauna aus der ægyptisch-arabischen Wüste: Zeitschr. d. Deutsch. Geol. Ges., XLVI., 1894. p. 68.

[2] *S. Nikitin:* Dépôts carbonifères et puits Artésiens dans la Région de Moscou. Mémoires Com. Géol. de la Russie. V, No. 5, St. Pétersbourg 1890, Tab. I. fig. 3, p. 56, 74.

[3] *Th. Tschernyschew:* Travaux exécutés au Timane en 1889, C. R. prél. Bull. Com. Géol. de la Russie, St. Pétersbourg, 1890, p. 63.

[4] *F. Toula:* Kohlenkalk-Fossilien von der Südspitze von Spitzbergen, Sitzgsber. Kais. Akad. d. Wiss. Wien LXVIII, 173, p. 285. Vide: *Tschernyschew*, Kostroma l. c. p. 22.

[5] *F. Toula* (Neues Jahrb. f. Miner., 1875, p. 227) considers the fossils from Nordenskjöld's Bed 4 in the section of Axel Island as being of permocarboniferous age. To this bed seems to correspond the fossiliferous sandstone of the South Cape of Spitzbergen, in which the present species has been collected by Payer, the well known Austrian explorer of the Arctic regions.

[6] *F. Teller* in *E. v. Mojsisovics:* Arktische Triasfaunen, Mem. de l'acad. impér. des sciences de St. Pétersbourg, sér vii, XXXIII, No. 6. 1886, p. 135.

## MOLLUSCOIDEA.

### Class: BRACHIOPODA.

### Order: TESTICARDINES, Bronn.

### Suborder: APHANEROPEGMATA, Waagen.

### Family: *PRODUCTIDÆ* Gray.

### Subfamily: CHONETINÆ, Waagen.

### Genus: CHONETES, Fisch. v. Waldh.

### Section: STRIATÆ, de Koninck.

**1. Chonetes Vishnu, Salter, Pl. II, fig. 5, 7, Pl. V, fig. 9.**

1865. *Chonetes Vishnu*, Salter, Palæontology of Niti, etc., by J. W. Salter and H. F. Blanford, p. 54, Pl. V, fig. 12, a. b.

1884. *Chonetes Vishnu*, Waagen, Salt Range Fossils, Pal. Ind., ser. xiii, I. Productus limestone fossils, p. 631.

In the Himálayan collection this species is almost exclusively represented by internal casts. In one specimen I have been able to examine the shelly layer of the dorsal valve, but in the ventral valve fragmentary portions only of the shelly substance were available for observation.

Otherwise a fairly complete diagnosis of the present species can be given, which will considerably add, I hope, to the rather short description given by Salter. A revision of Salter's diagnosis seemed the more desirable as the latter had proved insufficient to fix at all precisely the affinities of *Chonetes Vishnu* to *Ch. compressa* Waagen, from the Salt Range and to a considerable number of forms, described by Norwood and Pratten, from the North American coal measures.[1]

As Salter's memoir is extremely rare and the number of its copies, especially on the continent, very limited, I believe myself justified in quoting Salter's diagnosis verbally.

It runs as follows :—

" C. semiuncinalis, profunde biloba, transversa, auriculis nullis, striis angularibus, irregulariter bifurcatis et interlineatis, striis incrementi distinctis.

---

[1] Vide *Waagen*, l. c. p. 631.

"Transverse, the ears square, not produced. Half an inch broad, and about a quarter long, convex, strongly bilobed. The furrow reaching to the very beak. Striate. The striæ are angular, with equal spaces between them; they bifurcate very irregularly at all distances from the margin, and are wavy and rather nodular, crossed by somewhat distant, coarse lines of growth, and by very numerous close concentric striæ.

"Interiorly, lines of small and rather remote puncta are placed in the furrows between the ridges.

"This species differs from all allied forms described by de Koninck in the strong bilobation and the coarseness of the striæ. The coarse-ribbed species in his work are not flattened or bilobed. The bilobed species on the other hand are finely ribbed. *C. ardrensis*, a shell of the same size but without a furrow, comes nearest our fossil. It is the common British fossil."

This diagnosis will be completed by the following remarks:

The shell is of rather variable size. It is always considerably broader than long. In the specimen figured Pl. II., fig. 7, the breadth of the shell is nearly double its length. The straight hinge line is always as long as the greatest breadth of the shell. The outline is transversely rectangular with semicircular margins.

The ventral valve is rather strongly convex. The curve is in neither direction quite equal and regular. It is strongly flattened on the lateral parts both toward the wings and in the vicinity of the front margin. The demarcation between the strongly curved visceral region and the flattened marginal portions of the shell is more or less distinctly defined. The apex is scarcely prominent, pointed, and does not overlie the hinge line. Below it there extends a narrow, flat area, divided by a distinct deltidial fissure. No spines could be distinguished on the cardinal margins, limiting the area above.

Salter mentions that "the ears are square and not produced," no distinct wings being formed (auriculis nullis). This allusion has however reference to one of his type specimens only (*loc. cit.* Pl. V, fig. 12*b*) whereas the other (Pl. V, fig. 12*a*) is provided with clearly distinguishable, auriculate wings. Nor are they missing in any of my specimens.

A very deep, but comparatively narrow sinus extends from the apex to the front margin, but is gradually obliterated in the vicinity of the latter, increasing in width in the meantime and becoming cuneiform. It is sharply cut, but slightly rounded in its depth and bordered by steep marginal walls. The latter characters are however restricted to the central portion of the valve. No trace of a median fold is observed in the bottom of the sinus.

The ornamentation of the shell, as described by Salter, I have not been able to examine in detail all over the valve, as small fragments only of the shelly substance, adhering to the casts of my specimens, are available for comparison. They, however, agree well with Salter's description, as regards their sculpture, allowing the existence of numerous wavy, radial striæ, crossed by much more delicate concentric striæ and by coarse lines of growth, to be established. The surface of the cast exhibits numerous delicate radial furrows with regularly arranged puncta, closely resembling the grooves which are produced by the impressions of a sharp needle. These extremely delicate furrows are also occasionally intersected by coarse lines of growth.

The dorsal valve is distinctly, though very flatly, concave. I have not been able to state with certainty whether it is provided with a linear area. A median fold or varix, corresponding to the sinus in the ventral valve is but very slightly indicated.

The ornamentation of the interior consists in this valve of very numerous and delicate striæ, of which there are five to six in the space of one millimetre, so that as many as 100 or 120 striæ may be counted round the margins. Each striation bears about 20 tubercular shaped granulations, which are largest and thickest in the central portion of the valve, and slightly diminish in size towards the margins. The external sculpture is exactly the reverse of the ornamentation of the cast. To the striæ on the surface of the latter correspond wavy, irregular furrows, which are, however, much coarser and less numerous. Along them punctures and grooves are disseminated pointing towards the margin of the shell.

The internal structure of this species is not known to me.

The measurements of the largest specimen (Pl. II, fig. 5) are as follows:—

| | |
|---|---|
| Entire length of the shell . . . . . . . . . . | 9 mm. |
| „ breadth of the shell along the hinge line . . . . . . | 13 „ |
| Thickness of the ventral valve . . . . . . . . . . | 3·5 „ |
| Apical angle of the ventral valve without the wings . . . . . | app. 115° „ |

*Locality, number of specimens examined.*—N.W. Kiunglung encamping ground, S.W. Niti Pass, 7.

*Remarks.*—*Chonetes Vishnu* belongs to a group of strongly bilobed, striated forms, which make their first appearance in the mountain limestone of Belgium and Russia. The Belgian form has been described by L. de Koninck (Monographie des genres Productus et Chonetes, Liège 1847, Pl. XX, fig. 2, p. 206.) as *Ch. variolata* d'Orb. sp., the Russian by E. de Verneuil and Count Keyserling in Sir Roderick Murchison's "Géologie de la Russie d'Europe" (Vol. II, p. 242, Pl. XV, fig. 10 *d, e, f,* non *a, b, c,*) as *Ch. sarcinulata*, Schloth. sp. Both identifications are equally wrong. Waagen (*loc. cit.* p. 631) suggested that this ancestor of the bilobed species, which in upper carboniferous and in permocarboniferous strata become of very great importance, could, perhaps, be identified with the Indian *Ch. Vishnu*. This view has, however, not been proved correct. My examination of the Himálayan species leads to the result that *Ch. Vishnu* cannot be classed among the synonyms of the bilobed forms from the mountain limestone of Belgium and of Russia. The two species differ strongly both in the depth and shape of the sinus and by the shape of their profile.

Another species, which Waagen is inclined to consider as a synonym of *Ch. Vishnu* is *Ch. Flemingi*, Norwood and Pratten (Notice of the genus Chonetes, as found in the Westerns State and Territories, Journ. Acad. Nat. Sciences of Philadelphia, III, 1855, p. 26, Pl. II, fig. 5). This American species is indeed very closely allied to the present one, although I do not feel myself justified in uniting the two under a single denomination. In *Ch. Flemingi* the sinus seems to be a little wider and less deeply cut in. The ventral valve is more regularly convex, and not flattened towards the front margin, so far as one can judge from Norwood and Pratten's figure (Pl. II, fig. 5c). The cardinal edge is ornamented by seven obliquely directed tubes on each side of the beak, whereas in my Indian specimens no tubes have been observed, nor has their presence been mentioned by Salter. Nevertheless I am ready to admit, that both species are most nearly related, although difference may exist in the internal characters of the ventral valve, which in *Ch. Vishnu* are yet unknown.

Another species from the coal measures of North America, which seems, however, less closely allied to *Ch. Vishnu*, is *Ch. verneuiliana*, Norwood and Pratten (*loc. cit.* p. 26, Pl. II, fig. 6a, b, c).[1] Its ventral valve is more strongly convex, and its deep mesial sinus imparts to the front margin a much more distinctly bilobed outline than in the Indian species. A third remarkable character of difference consists in the large, rather prominent, and incurved beak of *Ch. verneuiliana*.

*Ch. Smithii* Norwood and Pratten (*loc. cit.* Pl. II, fig. 2, p. 24) and *Ch. granulifera* Owen (Geological Report of Wisconsin, Iowa and Minnesota, p. 583, Pl. V, fig. 12)[2] which among the American forms of the group of *Ch. Vishnu* might also be compared with our species, differ especially by their flat and indistinctly bordered mesial sinus. All these species are distinguished by the presence of spines on the cardinal edge.

Among the European species of this group *Ch. uralica*, Möller, is as nearly allied to our species, as *Ch. Flemingi* is among the American ones. Nikitin, who recently gave adequate descriptions of *Ch. uralica* (Dépôts carbonifères et puits artésiens dans la région de Moscou, Mém. du Comité Géol. de la Russie, Vol. V, No. 5, St. Pétersbourg 1890, p. 162, Pl. II, fig. 5, 6, 7, 8, 9), asserts, that Möller's species and *Ch. Flemingi* differ only in the internal characters of their valves, provided the figures in Norwood and Pratten's memoir are correct. Thus my remarks regarding the close relationship between *Ch. Vishnu* and *Ch. Flemingi* equally apply to *Ch. uralica*.

From the upper carboniferous strata of the Carnian Alps in Carinthia two species of *Chonetes*, belonging to the group of *Ch. Vishnu* have been described by E. Schellwien (Die Fauna des karnischen Fusulinenkalks, Palæontographica 39. Bd. 1892). Among them *Ch. latesinuata*, Schellw. (*loc. cit.* Pl. I, fig. 4—7, p. 30), is easily distinguished by its broad, triangular sinus, which widens out considerably towards the front margin. The second form, *Ch. lobata*, Schellw. (*loc. cit.* p. 29, Pl. I, fig. 1—3), is provided with a median fold in the bottom of its triangular mesial sinus, and in this respect resembles *Ch. liesarensis*, which will be described hereafter.

---

[1] Vide: *Meek* and *Hayden*, Final Report of the U. S. Geological Survey of Nebraska, Washington, 1872, p. 170, Pl. I, fig. 10.

[2] *Chonetes mucronata* Meek and Hayden. See *Geinitz*, Carbonformation und Dyas in Nebraska, Dresden, 1866. Tab. IX, fig. 12—14, p. 58, and *Meek* and *Hayden*, Final report, etc., p. 170, Pl. IV, fig. 9, Pl. VI, fig. 10, Pl. VIII, fig. 7.

Among the Indian congeneric species *Ch. compressa* has been placed in the group of *Ch. Vishnu* by Waagen (*loc. cit.* p. 630). It is however, according to the statement of this learned author, easily distinguishable from all the rest of the sinuated forms, " by its smooth wings and by the comparatively large spines, that are clustered together in the centre of the ventral valve." From *Ch. Vishnu* it differs moreover strongly by its much lower mesial sinus.

*Chonetes austeniana*, Davidson (Notes on the Carboniferous Brachiopoda, collected by Capt. Godwin Austen in the Valley of Kashmere, Quart. Journ. Geol. Soc. London, XXII, 1866, p. 44, Pl. II, fig. 18), from the Zewan beds in the Kashmir valley is too incompletely preserved to allow any comparison with *Ch. Vishnu*, although it seems to belong to the same group.

From the permocarboniferous rocks of Spitzbergen a small species of *Chonetes* has been described by F. Toula, which apparently belongs to the group of *Ch. Vishnu*. This author considers it to be a variety of *Ch. verneuiliana*, Norw. and Pratt., and especially remarks that it agrees perfectly with *Ch. Flemingi* in the arrangement of the puncta.

Through the kindness of Director Fuchs I have been enabled to examine Toula's type specimen from Axel Island (Permo-Carbon-Fossilien von der Westküste von Spitzbergen, Neues Jahrb. f. Mineral, 1875 p. 231, Taf. V, fig. 4.), but it is too badly preserved to allow any comparison of the minor details in the Indian and Spitzbergen fossils. The type specimen of Toula's *Ch. verneuiliana* var. *Spitzbergiana* from the Hornsund, which has been described and figured by this author in his memoir " Kohlenkalk-und Zechstein-Fossilien aus dem Hornsund von der Südwest küste von Spitzbergen" (Sitzgs.-Ber. Kais. Akad. d. Wiss. Wien, LXX, 1874, p. 17, Taf. I, fig. 10) is unfortunately not available to me for comparison. There can be no doubt, that according to Toula's figure this shell is extremely similar to our Indian species, and I must confess that, although I am not quite prepared to assert positively that both are identical, I should be at a loss to distinguish them without having Toula's specimen at hand. I may still add, that Toula's description might be applied, word for word, to *Ch. Vishnu*, and that in his specimen as in my Indian ones, no tubes have been observed along the cardinal edges.

The true *Ch. Vishnu* has not been found outside the Himálayan district of Painkhánda, but its nearest allies are among the leading fossils of upper carboniferous, permocarboniferous and permian strata. Although bilobed forms of this group make their first appearance in the mountain limestone, the typical species, which are characterised by a deep mesial sinus, do not descend into beds of lower carboniferous age. *Ch. uralica* occurs in the topmost carboniferous beds of Russia (Gshel-stage) and in the permocarboniferous Artinsk stage.

The age of the beds with *Ch. Flemingi* has not been determined by the authors of this species, but it has been fixed by latter observations as permocarboniferous or even permian. A similar age probably ought to be attributed to the beds with *Ch. spitzbergiana.*

### 2. CHONETES LISSARENSIS, nov. sp. Pl. II, fig. 4, 6.

This species, which is very nearly allied to the former, is one of the most common leading fossils of the Productus shales of the Lissar valley, where rock specimens are frequently made up entirely by the casts of its shells.

From *Ch. Vishnu* the present species differs especially by its trapezoidal outline with rounded-off margins, by the less strongly curved profile of its ventral valve, and by slight differences in its sculpture. It attains larger dimensions than *Ch. Vishnu*. The area seems to be smaller than in the latter form, although this cannot be ascertained on account of the impossibility of getting complete specimens out of the very tough matrix. The mesial sinus is cut in very sharply and is deepest in the visceral part of the ventral valve, but disappears almost completely in the vicinity of the front margin. In the majority of well preserved specimens a narrow median fold is observed in the bottom of the sinus. But the presence of this median fold is certainly not common to all the shells of *Ch. lissarensis*. This variability of the species may perhaps induce palæontologists to separate its two varieties under proper specific designations, but as the median fold is always small, and as transitional forms exist between the two types, I deemed it preferable to allow them to remain in the same species.

In spite of the large number of specimens, collected by Griesbach, not a single ventral valve with its shelly substance preserved has come to my notice. The ornamentation of the cast is different in the visceral and marginal portions of the valve. The visceral part is almost smooth, covered with very delicate striæ only, with puncta disseminated along with them, which are barely perceptible without a magnifying glass. In the vicinity of the margins, especially on the wings, the striæ become more distinct, and are interrupted by deep grooves, which are, as a rule, directed towards the margin of the shell.

The dorsal valve is distinctly concave and depressed along the hinge line. Its uneven surface does not exhibit any indication of a varix, corresponding to the mesial sinus of the ventral valve. The ornamentation of the shelly substance consists of very numerous, wavy furrows, many of which are formed by bifurcation. They are not interrupted by grooves, as in *Ch. Vishnu*, but small puncta only are placed between them occasionally. The cast of this valve exactly agrees in its ornamentation with that of the dorsal valve in *Ch. Vishnu*. It is covered all over with thin striæ and with a very large number of granulations.

The measurements of the specimen, Pl. II, fig. 4, are as follows :—

| | |
|---|---|
| Entire length of the shell . . . . . . . . . | 11·5 mm. |
| „ breadth „ „ „ along the hinge line . . . . . . | 17·5 |
| Thickness of the ventral valve . . . . . . . . . | 2·5 |
| Apical angle „ „ „ without the wings . . . . | app. 115° |

Of the internal characters of this species nothing is known to me.

*Locality, number of specimens examined.* South of Dharma No. XI, Lissar Valley, Johár, 15.

*Remarks.*—This species approaches *Ch. lobata.* Schellwien (Die Fauna des Karnischen Fusulinen-Kalks, *loc. cit.* p. 29, Taf. I, fig. 1-3) among the European, and *Ch. mesoloba*, Norwood and Pratten (Journal Acad. of Nat. Sciences, Philadelphia, III, 1855, p. 27, Pl. II, fig. 7) among the American species of the group of *Ch. Vishnu* in the well marked tendency to develop a median fold in the bottom of the mesial sinus of the ventral valve. In *Ch. mesoloba* this median fold is, however, much larger, filling out the mesial sinus almost completely.

## Subfamily: *PRODUCTINÆ*, Waagen.

### Genus: PRODUCTUS, Sowerby.

The genus *Productus* takes rather an important part among the fossils of the Productus shales, as the name chosen by Griesbach for the designation of the permian beds in Johár and Painkhánda clearly indicates. There are five different species, which can be attributed to this genus. Among the sections or subdivisions of *Producti*, established by L. de Koninck, two only are represented among these species, *viz.*, the groups of *Fimbriati* and of *Spinosi.*

Thus we arrive to the following grouping of the permian *Producti* in Griesbach's Himálayan collection:—

#### I. SECTION FIMBRIATI.

(a) Group of P. PURDONI, Dav.
  1. *Productus Purdoni*, Dav.
(b) Group of P. HUMBOLDTI, Orb.
  2. *Productus gangeticus*, nov. sp.
  3. *Productus cf. serialis*, Waagen.

#### II. SECTION SPINOSI.

4. *Productus cf. Cancrini*, Vern.
5. *Productus cancriniformis*, Tschern.

All the species of this genus, hitherto described which occur in the Productus shales of Gurhwal and Kumaon, are in other countries restricted to beds of permo-carboniferous or permian age, with the exception of P. *cancriniformis*, which in single specimens descends into upper carboniferous strata.

## I. SECTION: FIMBRIATI.

### *a*. GROUP OF PRODUCTUS PURDONI, Dav.

### 1. PRODUCTUS PURDONI, Davidson, Pl. II, fig. 1 a, b, c, d, fig. 2 a, b.

1862. ***Productus Purdoni***, Davidson, On some carboniferous brachiopoda, collected in India by A. Fleming and W. Purdon, Quart. Journ. Geol. Soc., London, XVIII, p. 31. Pl. II, fig. 5.

1863. ***Productus Purdoni***, Davidson, in L. de Koninck, Mém. sur les fossiles paléozoiques, recueillis dans l'Inde, Pl. XII, fig. 5, p. 38.

1884. ***P. Purdoni***, Waagen, Salt Range Fossils, Pal. Indica, Productus limestone Fossils, ser. xiii, I, p. 705. Pl. LXXIII, fig. 1-3.

This is one of the most characteristic species of the Salt Range Productus limestone formation. It has been mentioned by Salter among the fossils collected by Strachey in the Productus shales of the Painkhánda district, but I do not believe Salter's determination to be correct, the fragment, which he identified with ***Productus Purdoni*** belonging most probably to ***P. gangeticus***. Nevertheless the true ***P. Purdoni*** occurs in the Productus shales of the Himálayas. In Griesbach's collections from Kiunglung encamping ground near the Niti Pass the species is represented by a number of casts, which, although not entirely preserved, agree very well in their essential character with Davidson's and Waagen's type specimens. I have less hesitation in identifying them with ***P. Purdoni***, as Professor Waagen, who kindly examined my Himálayan fossils, likewise considers them identical with Davidson's species.

There are only ventral valves in Griesbach's collection. They are moderately inflated, much as ***P. Abichi*** or in ***P. gangeticus***, but nearly all of a larger size, some even considerably larger. They are longer than broad, and by this character even strongly weathered casts may be distinguished at once from the two above mentioned species.

The greatest breadth of the shells is situated in the lower part of their length. The hinge line is always considerably shorter than the greatest breadth of the valve, but in none of my specimens is it as short as in Davidson's type specimen or as in Waagen's strongly sinuated variety from Bilot (*loc. cit.* Pl. LXXIII, fig. 3). In this respect my specimens closely resemble Waagen's type specimen from the upper Productus limestone of Musakhel (Pl. LXXIII, fig. 2), but their wings are extremely small and not distinctly defined.

In one of my specimens the hinge line is arched, as in Davidson's type specimen. The margins are well rounded. The median sinus is broad but not very deep, although it extends, as a rule, to the front margin of the valve.

The apex is not well preserved in any of my valves, both the shelly substance and even the cast in part being strongly weathered. Thus its pointed, strongly incurved shape could not be observed. The beak seems to overhang the hinge line slightly.

In one of my specimens radial plications are noticed, as in Waagen's specimen from Musakhel (Pl. LXXIII, fig. 2). These indistinct and broad folds are only developed in the lateral parts and in the vicinity of the front margin. No median fold has been observed in the bottom of the mesial sinus.

Very little of the beautiful sculpture, which has been excellently described by Davidson and Waagen, is to be seen in my specimens, all of which are casts and more or less deteriorated by weathering. In the specimen, figured Pl. II, fig. 2 b, however, a small fragment of the shelly substance has been preserved in the vicinity of the apical region. Its ornamentation exhibits a vestige of the quincuncial arrangement of the flat tubercles, which in perfectly preserved shells produces a cross lineation of the surface. The visceral part of the cast is covered with roundish, shallow grooves, or, where it has been attacked by weathering more deeply, with delicate, longitudinal furrows. A comparison of Waagen's and my own figures will give a better idea than a detailed description of the similarity in the ornamentation of casts from the Salt Range and from the Himálayas. In the vicinity of the margins the tuberculation becomes extremely delicate.

In one of my specimens the interior characters of the valve are pretty well sculptured on the internal cast (Pl. II, fig. 2 a). The impressions of the cardinal or divaricator muscles form flat trapezoidal prominences, covered with deep, strongly marked furrows. The impressions of the adductor or occlusor muscles are not distinctly visible, but the narrow median ridge dividing them longitudinally is clearly indicated. In general the internal characters of the ventral valve do not seem to differ much from those of *P. Abichi.*

The measurements of my smallest specimen (Pl. II, fig. 1) are as follows:

| | |
|---|---|
| Length of the shell in a straight line | 51 mm. |
| " " " " along the curve | 80 " |
| Greatest breadth of the shell | 46 " |
| Length of the hinge line | 32 " |
| Thickness of the ventral valve | 23 " |

*Locality, number of specimens examined.*—N.W. Kiunglung encamping ground, S.W. Niti Pass, 4.

*Remarks.*—*P. Purdoni* has not yet been detected in any deposits of older than permocarboniferous or permian age. It is quoted by Wynne and Waagen from the upper division of the Salt Range Productus limestone. The oldest specimen has been collected in beds near the limit between the middle and upper Productus limestone, whereas the youngest specimens are met with in the topmost beds, immediately below the Ceratite formation. Tschernyschew (Mém. du Comité Géol. de la Russie, St. Pétersbourg, 1889, III, No. 4, p. 373) mentions the species from the Artinsk deposits of Podtscherem, Yomasch-Kirta and Kirta-Warta, where it has been collected by Hofmann in large numbers together with *P. tenuistriatus*, Vern.

Waagen considers *P. Purdoni* as an isolated form, which, as regards the peculiarities in its sculpture and shape, cannot be affiliated directly to the group of *P. Humboldti*. There is only one species of *Productus*, to which the present form is very nearly allied. This is *P. Payeri*, Toula (Kohlenkalk und Zechstein-Fossilien aus dem Hornsund, etc., Sitzgsber. Kais. Akad. der Wiss. Wien, LXX, 1874, p. 277, Taf. IV, fig. 1-3) from the permocarboniferous rocks of Spitzbergen.

It is true, that neither from Toula's figures nor from his description is this close relationship very conspicuous, but with Toula's specimens of *P. Payeri* at hand for comparison, the similarity to *P. Purdoni* is most striking, and there can be no doubt, that the two species must be placed in the same group.

In the Spitzbergen species the mesial sinus is, as a rule, deeper than in *P. Purdoni*, but in one of Toula's specimens it is exactly of the same size as in my Himálayan specimen figured on Pl. II, fig. 2. The ornamentation of the cast and of a few fragments of the shelly substance agrees equally well. In one cast radial plications are indicated near the lateral and front margins. The internal structure does not seem to differ from that exhibited by *P. Purdoni*. In Toula's specimen figured on Pl. IV, fig. 2 of his memoir, the dendritic impressions of the adductor or occlusor muscles are rather broad, but in a second specimen the space, which is left for the adductores between the trapezoidal impressions of the cardinal muscles, is of exactly the same size as in my Indian form.

One essential difference only makes the distinction of the two species easy. This is the length of the hinge line, which in the Spitzbergen species either corresponds to the greatest breadth of the shell or is but little inferior to the latter. It must however be stated, that with regard to the length of its hinge line *P. Purdoni* varies considerably. The importance of this character consequently ought not to be overrated, although it may be found very convenient for maintaining *P. Purdoni* *P. Payeri* as separate species.

The occurrence of a species, so closely affiliated to the characteristic *P. Purdoni*, which has been considered hitherto as an isolated form among the *Producti fimbriati*, in the permocarboniferous rocks of Spitzbergen is of high geological interest.

## *b.* GROUP OF PRODUCTUS HUMBOLDTI, ORB.

### 2. PRODUCTUS GANGETICUS, nov. sp., Pl. I, fig. 1 a-d, fig. 2, Pl. II, fig. 3.

1865. *Productus Purdoni*, Salter, Palæontology of Niti, etc., p. 53, Pl. V, fig. 10.
1895. *P. Abichi* (Waagen), Diener, Denkschr. Kais. Akad. d. Wiss. Wien, Math. nat. Cl., LXII, p. 595.

The determination of the present species has given me much trouble. At first I was inclined to unite it with *P. Abichi*, the well known Salt Range species, which has been excellently described and figured by Waagen (Salt Range Fossils, Pal. Indica, Prod. Limestone fossils, ser xiii, I. p. 697, Pl. LXXIV, fig. 1-7). The examination of its dorsal valve, and especially of its internal characters, however, convinced me, that it must be considered as a distinct species.

The ventral valves (Pl. I, fig. 1 and 2) are very similar to *P. Abichi*, both in shape and sculpture. They are moderately inflated and broader than long. But, as a rule, the difference between the length and breadth of the shell is considerably smaller than in the majority of Waagen's specimens of *P. Abichi*. The hinge line is shorter than the greatest breadth of the shell. The apex reaches almost down to the hinge line. The beak is strongly bent in and not very prominent. In the specimen Pl. I, fig. 1, no area is developed, but in the specimen fig. 2 a small area of more than one millimetre in breadth is distinctly defined along the hinge line. It is provided in the middle with a large deltidial fissure. This is again one of the numerous instances of species, belonging to the group of *P. Humboldti*, being eventually provided with a small area, as it is met with in the genus *Strophalosia*. But the point of attachment on the apex of the ventral valve, which is the most striking character in the true *Strophalosiæ*, is entirely absent in all the *Producti* of this group.

The general outline is transversely oval. The lateral margins are well rounded, uniting with the hinge line in an obtusely rounded-off angle, which is nearly rectangular. The curve of the ventral valve is tolerably regular in the longitudinal direction as far as its visceral portion. Near the limit of the visceral and frontal portions however a more or less distinct geniculation takes place. This geniculation marks the commencement of the trail. Transversely the curve descends rather abruptly from the flatly arched visceral part to the lateral margins. In the specimen Pl. I, fig. 2, the median sinus originates close to the apex, and is comparatively deep, as in Waagen's specimen of *P. Abichi*, figured on Pl. LXXIV, fig. 2, of the Salt Range Memoir (Vol. I). In my other specimens the sinus is more shallow, but in all of them it extends as far as the front margin.

The wings are very small, indistinctly limited off, and barely flattened.

In the sculpture of the shell, the difference between the visceral and marginal portions is very conspicuous. The coarse and elongated tubercles in the visceral part of the valve are towards the lateral and frontal margins replaced by much smaller, roundish spines, which are clustered together very closely. The shelly substance is extremely thin, scarcely more than one half millimetre in thickness. The sculpture of the cast is less distinctly marked. Where the interior cast is perfectly unhurt, as in the specimen fig. 1*a*, the elongated tubercles are yet visible, but where its surface has been subject to weathering, sharp, longitudinal grooves appear instead of them. Along the margins the cast is covered with small, pustule-shaped granulations. In one of my specimens a few concentric striæ of growth are faintly indicated in the vicinity of the wings.

In general the sculpture of this valve approaches very nearly that of *P. Abichi*. The arrangement of the tubercles is almost absolutely identical, and the only point of difference is the somewhat smaller size and larger number of the single tubercles in the visceral part of the shell. But even in this respect my specimens do not differ remarkably from the specimen, described by Geheimrath Abich[1] as *P. scabriculus* from the permian rocks of Djulfa.

The dorsal valve is flatly convex with a slightly vaulted apical region. A broad, median fold, originating in the apex and reaching down to the front margin, corresponds to the mesial sinus of the ventral valve. The lateral margins are quite flat. The wings are slightly excavated and bent up along their margins.

---

[1] *H. Abich*, Geologische Forschungen in den Kaukasischen Ländern. I. Th. Eine Bergkalkfauna aus der Araxes Enge bei Djoulfa. Wien, 1878, p. 33, Taf. V, fig. 3.

In its general shape this valve differs considerably from the dorsal valve of *P. Abichi*, which is provided with a distinctly excavated apex and with two broad lateral folds besides the median fold. It approaches more nearly the dorsal valve of *P. Purdoni*, Dav., in which the apical region is also slightly raised. A chief difference consists, however, in the concave shape of the whole valve in consequence of its margins being bent up more or less strongly, whereas in *P. gangeticus* the dorsal valve is distinctly though flatly convex.

The sculpture consists of very numerous little grooves, between which small erect spines are occasionally intercalated. A concentric folding is moreover faintly indicated. On the external cast (Pl. II, fig. 3) small, elongated, club-shaped tubercles correspond to the grooves in the shell.

The internal structure of the dorsal valve is rather remarkable. It is tolerably well exhibited in two of the specimens, figured on Pl. II, fig. 3.

The cardinal process is bipartite and is laterally supported by two horizontal ridges, extending along the hinge line. These two ridges have not been represented in the figure with sufficient distinctness. Although they are far inferior in strength and size to the corresponding ridges in *P. Abichi* and in *P. serialis*, Waag., they are clearly visible in my type specimens. The cardinal process is continued on the inner side by two stout, diverging ridges, which extend probably for about one third of the visceral part of the valve. Between these two ridges a sharp, blade-like median septum is developed, which apparently extends as far as the visceral portion of the valve. In some of my specimens an angular ridge, which is thickly set with roundish spines, distinctly marks off the edge of the visceral part from the trail.

The internal structure of the dorsal valve of *P. gangeticus* differs widely from that of other species of the *Humboldti* group. The *Producti* of this group from the Salt Range, so far as their internal characters are known, *viz.*, *P. Abichi*, and *P. serialis*, are distinguished by a trifid cardinal process, which is continued interiorly into a median septum. The bipartite character of the cardinal process, as it has been observed in *P. gangeticus*, recalls the genus (or subgenus) *Productella*, Hall, and among the geologically younger species of *Producti*, of *P. Cancrini*, Vern.[1] and of *P. tibeticus* Frech., from the permian or permocarboniferous limestone discovered by Bogdanowitsch near the Gussass River in the Western Kuen-Lun Mountains.[2]

The measurements of the specimen figured Pl. I, fig. 1 with partly preserved trail, are as follows :—

| | |
|---|---|
| Length of the shell in a straight line . . . . . . . | 44 mm. |
| " " " " along the curve . . . . . . . . | 74 " |
| Greatest breadth of the shell . . . . . . . . . | 48 " |
| Length of the hinge line . . . . . . . . | app. 42 " |
| Thickness of the ventral valve . . . . . . . . | 24 " |

---

[1] *Vide Geinitz*, Dyas, Taf. XVIII, fig. 22*a*, p. 101.

[2] *F. Frech*, Brachiopodenkalke vom Flusse Gussass; in *E. Suess*, Beiträge zur Stratigraphie Central-Asiens Denkschr. kais. Akad. d. Wiss, Wien, math. nat. Cl., LXI, 1894, p. 454, fig. 10.

The measurements of a dorsal valve (Pl. I, fig. 3) are as follows :—

| | |
|---|---|
| Length of the shell in a straight line | 31 mm. |
| " " " " along the curve | 63 " |
| Greatest breadth of the shell | 44 " |
| Length of the hinge line | 29 " |
| Thickness of the dorsal valve | app. 6 " |

Since the examination of the internal structure of the dorsal valve has convinced me of the necessity of a specific distinction between *Productus gangeticus* and *P. Abichi*, I have come to the conclusion that the larger size of my specimens may serve as a valuable character of difference, if one has to deal with ventral valves only. *P. Abichi* is always smaller than the present species, Waagen's largest specimen of his Salt Range form, with a length of 34 mm. corresponding to a breadth of 42 mm., remaining somewhat behind my smallest specimens of *P. gangeticus.*

*Locality, number of specimens examined.*—N.W. Kiunglung encamping ground, S.W. Niti Pass, 11.

*Remarks.*—It is obvious from the preceding description that the present species cannot be identified with *P. Abichi*, in spite of the misleading similarity of the ventral valve. Chief points of difference are the convex shape and the remarkable internal structure of the dorsal valve in *P. gangeticus.* To these may be added as minor differences the larger size and the more numerous but less coarse tubercles in the ventral valve of the Himaláyan species. Whether the presence of a trail constitutes a character of difference, I am not able to assert. In *P. Abichi*, it is true, no trail has been observed by Waagen, but in the very nearly allied *P. serialis*, Waagen (*loc. cit.*, Pl. LXXIV, fig. 8, Pl. LXXV, fig. 1, 2, p. 700), the presence of a trail is noticed by this learned author. Thus the absence of a trail in Waagen's specimens of *P. Abichi* may after all only be due to their state of preservation.

With other species of the *Humboldti* group I scarcely need compare *P. gangeticus.* I may only call attention to the fact, that, with regard to the sculpture of the ventral valve, it somewhat approaches the true *P. Humboldti*, d'Orbigny (Voyage dans l'Amérique Méridionale, Paléontologie, III, 4 ^me partie, p. 54, Pl. V, fig. 4, 7) and *P. Waageni*, Rothpletz.[1] As has been stated in the foregoing description, the tubercles are more numerous but less coarse than in *P. Abichi*, although the character of the ornamentation is yet more similar on the whole to that of *P. Abichi* than of any other species belonging to the group of *P. Humboldti.*

The fragment of a *Productus* in Strachey's collection, which Salter identified with *P. Purdoni*, Dav., is too imperfect to allow any exact determination. It probably belongs to *P. gangeticus*, not to Davidson's species.

Another species of this group, which has been hitherto erroneously identified with *P. Humboldti*, Orb., is represented by the specimen, described by F. Toula in his memoir "Kohlenkalk-Fossilien von der Südspitze von Spitzbergen (Sitzungsber. Kais Akad. d. Wiss. Wien, math. nat. cl., LXVIII, 1873, p. 282, Taf. II, fig. 3).

---

[1] *Rothpletz* (Die Perm, Trias-und Juraformation auf Timor und Rotti, Palæontographica, XXXIX, 1892, p. 77) assigned this name to the Indian species, which has been identified by Waagen (*loc. cit.* p. 695) with *P. Humboldti*, Orb. Nikitin (Mém. du Com. Géol. de la Russie, St. Pétersbourg 1890, V, No. 5, p. 159) likewise refused to identify the Indian and Russian *P. Humboldti* with d'Orbigny's South American species.

This species, to which a new denomination will have to be assigned, differs from d'Orbigny's type species as well as from the Russian *P. Humboldti*, Keyserling (Petschoraland, *loc. cit.* p. 201, Taf. IV, fig. 3) and from *P. Waageni*. The tubercles are strongly elongated, much more numerous and clustered together quite closely, without exhibiting an equally regular quincuncial arrangement. The difference in the ornamentation of the marginal and visceral portions of the ventral valve is less distinctly marked, than in *P. Humboldti*, and considerably less strongly, than in *P. Waageni*, *P. serialis*, *P. Abichi* or *P. gangeticus*. Concentric plications are distinctly developed in the lateral parts, but do not extend to the middle portion of the ventral valve.

This fact is of some interest in connection with the geological distribution of *P. Humboldti*, as it seems to prove that the true *P. Humboldti* is entirely confined to carboniferous deposits, whereas it is represented in geologically younger strata by other forms, which although belonging to the same type, are yet specifically distinct.

### 3. PRODUCTUS cf. SERIALIS, Waagen, Pl. I, fig. 4.

1884. *Productus serialis*, Waagen, Salt Range Fossils, Palæontologia Indica. Productus limestone Fossils ser. xiii, I, p. 700, Pl. LXXIV, fig. 8, Pl. LXXV, fig. 1, 2.

The materials of this species in the Himálayan collection are so insufficient that the determination itself can only be admitted as provisional.

The incomplete fragment of an external cast of the dorsal valve, which serves for description, exhibits an ornamentation similar to that of *P. serialis*. The entire valve must have been of a comparatively large size, scarcely less than 45 mm. in length, and 65 mm. in breadth. That it cannot belong to a variety of the preceding species (*P. gangeticus*), is proved by its distinctly concave shape, a character, which is common to *P. Abichi* Waag. and its allies.

In the sculpture of the cast two characters are most strongly marked, a very conspicuous difference in the ornamentation of the central and marginal portions, and the presence of distinct concentric folds. The central part of the cast is covered with coarse, elongated tubercles, which are club-shaped and quincuncially arranged. In the marginal belt the tubercles are much more numerous, smaller and roundish. The shell must have been covered by corresponding pits in the marginal, and furrows in the visceral portions.

In comparing this fragment with *P. serialis*, I am well aware, that it does not agree with the latter in every respect. But Waagen's species itself has been founded on three specimens only, which deviate from each other by certain peculiarities in their sculpture. As the differences between Waagen's specimens themselves are barely less remarkable than those between them and my fragment, I deemed it best to leave the latter with *P. serialis*, which is altogether a more loosely defined species, as has been admitted by Waagen, than others belonging to the genus *Productus*.

*Locality, number of specimens examined.*—N.W. Kiunglung encamping ground, S. W. Niti Pass, 1.

*Remarks.*—*Productus serialis* is quoted by Waagen from the Cephalopoda beds of the upper Productus limestone (Jabi beds). Although my fragment is not directly identical with this species, it may be worth mentioning that its nearest ally has as yet only been found in beds of permian age.

## II. SECTION: SPINOSI.

### 4. PRODUCTUS CF. CANCRINI, Verneuil, Pl. I, fig. 5, 6.

1842. *Productus spinosus*, Kutorga (non Sowerby), Verh. kais. mineral. Ges. St. Petersburg, p. 18. pl. V, fig. 2.
1845. *P. Cancrini*, Verneuil, in Murchison, E. de Verneuil et A. comte de Keyserling, Géologie de la Russie d'Europe, Vol. II, Paléontologie, p. 273, Pl. XVI, fig. 8, Pl. XVIII, fig. 7.
1846. *P. Cancrini*, Keyserling, Wissenschaftliche Beobachtungen auf einer Reise in das Petschoraland, St-Petersburg, p. 205, Taf. VIII, fig. 7.
1847. *P. Cancrini*, L. de Koninck, Monographie des genres *Productus* et *Chonetes*. p. 105, Pl. XI, fig. 3.
1878. *P. Cancrini*, L. de Koninck, Nouvelles notices sur les fossiles du Spitzberge, Bull. Acad. Royale de Belgique, Vol. XVI, Pt. ii, p. 632, fig. 2.
1858. *P. Cancrini*, Davidson, British fossil Brachiopoda, Pt. IV, Permian Brachiopoda, p 47.
1861—63. *P. Cancrini*, Geinitz, Dyas, p. 101, Taf. XVIII, fig. 22—27.
1866. *P. Cancrini*, Geinitz, Carbonformation und Dyas in Nebraska, p. 51, Tab. IV, fig. 6.
1872. *Productus pertenuis*, Meek and Hayden, *pro parte*, Final Report of the U. S. Geological Survey of Nebraska, p. 164, Pl. I, fig. 14 (non Pl. VIII, fig. 9).
1874. *P. Cancrini*, Toula, Kohlenkalk und Zechstein-Fossilien aus dem Hornsund an der S.W. Küste von Spitzbergen, Sitzgsber. Kais. Akad. d. Wiss. Wien, LXX, Juniheft, p. 13, fig. 9.
1875. *P. Cancrini*, Toula, Permo-Carbon-Fossilien von der Westküste von Spitzbergen, Neues Jahrb. f. Min. 1875, II. Bd, p. 251, Taf. VIII, fig. 7.
1885. *P. Cancrini*, Tschernyschew, Der permische Kalkstein im Gouvernement Kostroma, Separatabdr. Verh. d. Kais. Mineral. Gesellsch. i. St. Petersburg 1884, p. 33, Taf. XVIII, fig. 37, 38.

The materials of this species in the Himálayan collection are too scanty to allow the determination to be made with accuracy.

There are only two ventral valves available for description, and they are not completely preserved, the cardinal region having been broken off in both of them. They are not very strongly vaulted, and probably about as broad as long. A very flat mesial sinus is faintly indicated, as it is mentioned by Count Keyserling in the flat variety of this species, distinguished by the presence of a shallow sinus and by very elongated spines. The specimen Pl. I, fig. 6, is of the oblique shape, attenuated towards the apex, which is mentioned by Verneuil as being frequently met with in specimens of *P. Cancrini*.

The most characteristic feature is the sculpture, which agrees perfectly well with that in *P. Cancrini*. The surface is covered with numerous, delicate, longitudinal striæ, which are frequently dichotomous and are interrupted by elongated, cylindrical spines. In the smaller specimen (Pl. I, fig. 6.) this sort of sculpture is particularly well exhibited. In the visceral part there are about 20 striæ in a space of 10 millimetres. The numerous, longitudinal spines are arranged quincuncially. Their base is either formed by two separate striæ or by a single one. In general the sculpture is exactly of a character, which has been justly compared by previous authors with a fur cape, trimmed with ermine tails.

This ornamentation points to a group of forms, which is represented by ***P. koninckianus***, Keyserling (Wissenschaftliche Beobachtungen auf einer Reise in das Petschoraland 1876, p. 203, Taf, IV, fig. 4.)[1] in the carboniferous and permocarboniferous[2] and by ***P. Cancrini*** in the permocarboniferous and permian strata. These two species resemble each other very closely. Among all the characters of difference, which have been enumerated by Count Keyserling, only one invariably holds good, according to Tschernyschew's opinion, and this is the shape of the dorsal valve. In ***P. koninckianus*** (= ? ***P. Villiersi*** Orb.) the dorsal valve is regularly vaulted, whereas it is distinctly geniculated in ***P. Cancrini***.

As my specimens consist of ventral valves only, my determination must be based on a combination of the less characteristic points of difference which I quote from Keyserling's memoir. According to his description, ***P. koninckianus*** is smaller than ***P. Cancrini***, as a rule not longer than 20 mm. and much more strongly vaulted. Its lateral parts are of a semicircular shape and its apical region is more strongly contracted. The striæ are more delicate and numerous. In the visceral part of the shell 20 striæ may be counted to a space of 2 mm., and 4 between two spines of the same transverse row. My larger specimen is at least 25mm. in length. Both of my shells are moderately vaulted, their lateral parts are not bent inwards, and the number of their striæ is only 5 in 2 mm., or 2 between two spines of the same transverse row. I consequently prefer to identify my specimens with ***P. Cancrini***, although only a very slight importance is attributed by Tschernyschew to all the above mentioned characters.

Among the section of the ***Producti semireticulati*** there is a small group of forms, which in their sculpture are similar to a certain extent to the group of ***P. Cancrini***. Among them are especially ***P. Flemingi*** Sow.,[3] and ***P. carbonarius*** de Koninck (Prod. et Chon. p. 90., Pl. V, fig. 4), to which my two specimens might be compared. One of the ***Producti*** in Strachey's collection has been considered by Salter (Palæontology of Niti, p. 53, Pl. V, fig. 11) as belonging to one of these species, but Salter's figures are absolutely insufficient for ascertaining the accuracy even of the generic determination. I do not think that my fossils can be attributed to either of these two species, from which they differ by the absence of any concentric striæ, and by their elongated spines, whereas in ***P. carbonarius*** the tubes are rather short and narrow.

Another question still remains to be settled whether our specimens ought not to be attributed to ***Strophalosia morrisiana***, King (A Monograph of the Permian Fossils of England, 1850, p. 99, Pl. XII, fig. 18—32). As has been remarked by King, Geinitz (Dyas, p. 101) and Toula, ***Strophalosia morrisiana*** and ***Productus Cancrini*** are much more nearly related to each other, than might be supposed from their attribution to two different genera. According to Geinitz the distinction of young specimens is even very difficult. The apical region having not been preserved in any of my specimens, their most distinctive characters, *viz.*, the presence of a point of attachment and of a distinct area, cannot be noticed. The only point I can insist on, is the absence of any concentric wrinkles in the sculpture of my shells, whereas in none of King's type specimens of *S. morrisiana* are concentric wrinkles or striations entirely absent.

---

[1] *Tschernyschew* (Der permische Kalkstein von Kostroma, p. 34) identifies *P. koninckianus* with *P. Villiersi* d'Orbigny (Voyage dans l'Amérique Méridionale, Paléontologie, 1872, Pl. IV, fig. 13, 14, p. 63).

[2] Count Keyserling considered *P. koninckianus* to be a carboniferous species. Tschernyschew, however, proved the beds from which it has been collected in the Timan, to be of permocarboniferous age (Travaux exécutés au Timane en 1889, Bull. Com. Géol. de la Russie, St. Pétersbourg, IX, 1890, p. 83).

He also quotes it from the permocarboniferous dolomite limestone horizon of the Central Ural (Mém. Com. Géol., St. Pétersbourg, III, No. 4, p. 361).

[3] *L. de Koninck*, Monographie des genres *Productus* et *Chonetes*, p. 95, Pl. X, fig. 2 a, b, c—f, fig. 3 h.

There is yet another argument in favour of an identification of the present specimens with *P. Cancrini*, and this is the fact that the genus *Strophalosia* seems to be altogether absent in the carboniferous and permian beds of the Himálayas. No *Strophalosia* is mentioned by Davidson among Godwin-Austen's large collection of carboniferous fossils from Kashmir, nor is one single species of this genus contained in the rich fauna of Chitichun No. I of permocarboniferous age. This is a strong evidence against the probability of the present specimens belonging to *Strophalosia*. I consequently deemed it preferable to identify them with *P. Cancrini*, although they are not sufficiently complete to warrant a certain identification.

*Locality, number of specimens examined.*—N. W. Kiunglung encamping ground, S.W. Niti Pass, 2.

*Remarks.*—*Productus Cancrini* is among the most characteristic permian species. L. de Koninck (l. c. p. 107) even compares it to *P. giganteus* in the lower carboniferous regarding its geological importance. Murchison, Verneuil and Count Keyserling collected *P. Cancrini* in the lower permian strata of Russia at a large number of localities. Tschernyschew mentioned it from the lower permian rocks of Kostroma. Geinitz quotes it from the Weissliegende in Germany and from Marcou's stage Cc II of his section at Nebraska city; but this identification of the American species with the true *P. Cancrini* has not been left unopposed. It is moreover mentioned by L. de Koninck and by F. Toula from Spitzbergen (Belsund, Hornsund), where it occurs in beds of probably permocarboniferous age. It certainly does not descend into carboniferous strata, but its occurrence in permocarboniferous deposits can scarcely be doubted. In the Artinsk stage of Russia which must serve as a prototype of the permocarboniferous horizon in Europe, the closely allied *P. cancriniformis* takes the place of *P. Cancrini*, but in the Timan the true *P. Cancrini* has been collected by Tschernyschew in oolitic limestones and marls, which correspond in age to the permocarboniferous limestone-dolomite horizon (C Pc) of the Ural, following there immediately above the Artinsk marls.[1]

In the Productus Limestone Formation of the Salt Range *P. tumidus*, Waagen (Salt Range Fossils, Pal. Ind. ser. xiii, I, Prod. Limest. Foss, p. 708, Pl. LXXX, fig. 1-3) seems to be a representative of the Russian *P. Cancrini*. When introducing his Salt Range species, Waagen placed it among the section of the *horridi*, but considered its systematic position to be "to a certain extent doubtful."

---

[1] *Th. Tschernyschew*, Travaux exécutés au Timane en 1889, Boll. Comité Géol. de la Russie, St. Pétersbourg, 1890, IX, p. 93.

It was only after Tschernyschew's paper on the permian fauna of Kostroma had been published, that he was struck by the strong similarity of *P. tumidus* with the figure of *P. Cancrini* given by Tschernyschew. "The same wavy lines"—he remarks—" the same irregular distribution of spines are exhibited by both figures. Whether there exists, however, a real identity, I am not able to decide, as no authentic specimens of the Russian form are at my disposal for comparison."[1]

To me an identification of the two species does not appear advisable. Waagen in his description of *P. tumidus* states the dorsal valve to be deeply and regularly concave, whereas it is distinctly geniculate in *P. Cancrini*. Thus *P. tumidus* is brought into a similar relationship with *P. Cancrini* as *P. koninckianus*. That all these species are very nearly allied to each other cannot be doubted.

*P. tumidus* holds a geological position similar to that of *P. Cancrini*, having been collected in the Virgal and Kalabagh beds of the middle Productus limestone and in the Cephalopoda beds of the upper Productus limestone.

### 5. PRODUCTUS CANCRINIFORMIS, Tschernyschew.

Pl. I, fig. 7 a—d, 8, 9 a—d, 10 a—d.

1889. *Productus cancriniformis*, Tschernyschew, Allgemeine geologische Karte von Russland, Blatt 139, Beschreibung des Central-Urals und des Westabhanges, Mémoires du Comité geologique de la Russie, St. Pétersbourg. III, No. 4, p. 373, Pl. VII, fig. 32. 33.
1891. *P. latirostratus*, (Howse) *var.* Griesbach, Geology of the Central Himálayas, Mem. Geol. Surv. of India, XXIII p. 121.
1892. *P. cancriniformis*, Schellwien, Die Fauna des Karnischen Fusulinenkalks, Palæontographica, 39 Bd. p. 22, Taf. VIII, fig. 20, 21.
1894. *P. tibeticus*, Frech, *ex parte*, in E. Suess, Beitraege Zur Stratigraphie Central-Asiens, Denkschr. kais. Akad. d. Wiss. Wien, LXI, math. nat. Cl. p. 454.

This is the most common species of the present genus in the Productus shales near Kiunglung encamping ground, where slabs of rock are made up entirely of its shells, associated with *Spirigerella Derbyi*, *Chonetes Vishnu* and *Aviculopecten hiemalis*.

Its dimensions are always moderate, and specimens as large as the one figured on Pl. I, fig. 9 are exceptions. Its shape is extremely variable. Although most of my specimens are somewhat deformed, it is not difficult to reconstruct their proper outlines. They are, as a rule, longitudinally oval. Specimens, which are a little broader than long, are rather rare (fig. 10). Usually they are longer than broad, the disproportion in these two dimensions being sometimes very considerable.

The ventral valve is more or less strongly convex, in some of my specimens nearly spirally inrolled, provided with small auricular expansions, and with a short, barely prominent apex. The hinge line is always shorter than the transverse diameter of the shell. The lateral parts ascend very steeply, in some of my specimens quite perpendicularly from the margins towards the highly elevated visceral portion. A median sinus is completely absent. The dorsal valve is distinctly geniculate, as in the typical representatives of *P. Cancrini* Vern.

[1] *W. Waagen*, Salt Range Fossils, Pal. Ind. ser. xiii, IV, Geological Results, p. 193.

The sculpture differs from the ornamentation of the shell, exhibited in *P. Cancrini*, by the presence of strong, concentric folds, which are often undulating or wrinkled, and extend from the wings and lateral margins across the entire shell.

The measurements of an average sized specimen are as follow :—

| | |
|---|---|
| Length of the shell in a straight line . . . . . . . | 18 mm. |
| „ „ „ „ along the curve . . . . . . . . | 32 „ |
| „ „ „ hinge line . . . . . . . . . | 11 „ |
| Thickness of the ventral valve . . . . . . . . | 10 „ |
| Greatest breadth of the shell . . . . . . . . . | 17 „ |

So variable do the shells composing this species appear to be, that in spite of their striking similarity with the typical *P. cancriniformis* I did not dare at first to identify them with Tschernyschew's species without materials of the latter available for comparison. I am therefore greatly indebted to Professor Tschernyschew for having examined my type specimens (including the specimen from the Gussass River). He fully confirms their identity with his *P. cancriniformis*.

" Your Indian specimens of *P. cancriniformis* "—he writes—" do not differ in any way, according to my opinion, from our Artinskian form, although they are somewhat deformed and not so well preserved as our examples from the Ural Mountains. In all your specimens the wrinkled transverse folds are distinctly as in our Russian representatives of the species, and a row of thin and closely arranged spines is placed along the cardinal edge. The geniculate condition and sculpture of the dorsal valve agree perfectly well with that of the Artinskian species."

Having obtained from Professor Tschernyschew the loan of his type specimens of *P. cancriniformis*, and having compared them with my Indian examples, the result was, that I could perceive no difference in their essential characters, and I consequently fully agree with the opinion of this learned author in believing them to be identical.

*Locality, number of specimens examined.*—N.W. Kiunglung encamping ground, S.W. Niti Pass.

*Remarks.*—The differences, which exist between the present species and its nearest allies, have been described by Tschernyschew so excellently, that I have nothing to add to his valuable observations.

*P. cancriniformis* is a very characteristic species of the Artinskian horizon in the Ural Mountains. Outside of Russia it has been mentioned by Schellwien from the Carnian Fusulina limestone of the Krone, of upper carboniferous age.

In Central Asia this species is represented among the fauna of the brachiopod-bearing limestone near the Gussass River (western Kuen Lun Mountains). One of the specimens collected by Bogdanowitsch and identified by Frech with *Productus tibeticus*, which belongs to the geological collections in the museum of the Vienna university, agrees in every respect perfectly with my Himálayan specimens from the Productus shales. It is the specimen, figured on Pl. I, fig. 7 a—d. Whether *P. tibeticus* Frech ought to be placed altogether among the synonyms of *P. cancriniformis*, I do not venture to decide, as Frech's type specimen (*loc. cit.* fig. 10) is not available to me for comparison. To judge from the figure, I should think that the difference in the outlines is not in favour of their identity. Nevertheless *P. tibeticus* is certainly most nearly allied to *P. cancriniformis.* They agree both in their sculpture and in the geniculate curvature of the dorsal valve. The bipartite cardinal process in the smaller valve is also a peculiar feature of the group of *P. Cancrini.*[1] The similarity with the devonian *Productella Herminæ*, which has been noticed by Frech, is less conspicuous, although it cannot be denied.

The occurrence of *P. cancriniformis* in the fauna of the Gussass River is not without interest. The limestones containing this fauna have been reported by Bogdanowitsch to overlap unconformably all the older beds including carboniferous strata with *P. semireticulatus* (horizon of *P. Cora*), but the fauna itself has been considered by Frech as not adapted for any determination of its geological age. The fossils described by him are the following :—

*Productus tibeticus*, Frech.
*Streptorhynchus difficilis*, Frech.
*Orthis nov. sp. aff. indica*, Waag.
*Martinia planoconvexa*, Shumard.

The last mentioned species passes in its typical shape from devonian into permian deposits. The rest of the species, which are new, exhibit equally strong affinities to permian as to devonian forms. The presence of *P. cancriniformis* is therefore of considerable geological importance, as it leads to the conclusion that the limestones of the Gussass River must be placed either very high in the carboniferous series or more probably even on a level with the permocarboniferous or permian strata of other countries.

## Suborder: HELICOPEGMATA, Waagen.

### Family: *SPIRIFERIDÆ*, King.

### Subfamily: DELTHYRINÆ, Waagen.

### Genus: SPIRIFER, Sowerby.

Although representatives of this genus are not very numerous in the Himálayan Productus Shales, six different species may be distinguished among them. Of these six species only one has been previously described, three are new to science, whereas the determination of the rest can only be admitted as provisional, regarding the insufficient materials. The majority of the species belong to the group of *Spirifer fasciger*, Keyserling.

---

[1] Vide *Geinitz*, Dyas, Taf. XVIII, fig. 22 a., p. 101.

### *a*. Group of SPIRIFER STRIATUS, Mart.

#### 1. Spirifer Ravana nov. sp., Pl. III, fig. 1*a*, *b*, *c*, fig. 2.

1895. *Spirifer nov. sp. ex. aff.* Sp. *Marcoui* Diener, Denkschr. Kais. Akad. d. Wiss. Wien. math. nat. Cl., LXII, p. 595.

The present species is very nearly related to ***Spirifer Marcoui***, Waagen (Salt Range Fossils, Pal. Indica, ser. xiii, Vol. I. Prod. Limest. Foss. p. 510, Pl. XLVII), and it is only a matter of taste, whether the differences between them be admitted or not as sufficient for the distinction of two separate species.

The Himálayan type specimens differ from ***Spirifer striatus*** Mart. (L. de Koninck, Faune du calcaire carbonifère de la Belgique, Annales du Musée d'hist. nat. de Belgique, XIV, pt. 6 Bruxelles, 1887, p. 112, Pl. XXIII, fig. 1, 2, Pl. XXVII, fig. 1) by the same characters which induced Waagen to separate ***Sp. Marcoui*** from Martin's species. Their most conspicuous peculiarity is the deep sinus of the ventral valve. It is sharply impressed in the middle and limited on both sides by obtuse ridges or folds. Two or three similar, very broad and flat ridges or folds are distinctly indicated in the remainder of the shell.

The radial striation is of exactly the same character as in ***Sp. Marcoui***. All the ribs are likewise crossed by strong, imbricating lines of growth at irregular distances.

The apical region of my type specimen is strongly corroded by weathering; no exact idea of its shape can consequently be got. It is due to this circumstance only, that the apical angle appears to be so extraordinarily large in this specimen. The area is very broad, distinctly concave, and covered with horizontal striæ intersected by numerous very delicate vertical lines. The triangular fissure is bordered by margins of nearly equal length, and is covered up by the rocky matrix. It can therefore not be observed, whether a pseudodeltidium has been present or not.

Neither the dorsal valve, nor any of the internal characters are known to me.

The measurements of a tolerably complete ventral valve from Kiunglung encamping ground (Pl. III, fig. 1) are, approximately, as follows :—

| | |
|---|---|
| Entire length of the shell . . . . . . . . . . | 70 mm. |
| " breadth " " " . . . . . . . . . | 120 " |
| Thickness of the valve . . . . . . . . . . app. | 40 " |
| Breadth of the area . . . . . . . . . . . | 16 " |

The only points of difference between ***Sp. Marcoui*** and my Himálayan specimens consist in the concave shape of the area of the latter, and in the presence of broad, shallow ridges or folds, following the direction of the striæ. By the presence of these folds a certain similarity is exhibited between our species and ***Sp. musakheleneis***, Dav., and its allies. But this similarity is only a rather distant one, as in ***Sp. Ravana*** the folds do not correspond to separate bundles of striæ. From Waagen's type specimen of ***Sp. Marcoui*** my specimen from Kiunglung differs, moreover, by its considerably broader area. But the breadth and shape of the area is a character of very small importance among the ***Spiriferidæ***, and in many species it varies so considerably, that it cannot be considered as being of any specific value. I only need to mention Bittner's[1] detailed examination of the variability of the area in ***Spiriferina* (*Mentzelia*) *Mentzelii***, Dunker, or among Himálayan species in ***Spiriferina Griesbachi***[2] from the upper trias of Kumaon and Spiti.

With regard to the breadth and shape of the area ***Sp. Ravana*** absolutely agrees with Marcou's type specimen of ***Sp. Marcoui*** (Geology of North America, Zürich, 1858, p. 49, Pl. VII, fig. 2, 2*a*.) from Pecos village (New Mexico), and with ***Sp. Marcoui***, Tschernyschew (Mém. Com. Géol. de la Russie, St. Pétersbourg, 1889, III, No. 4, p. 367, Pl. V, fig. 5) from the Artinskian deposits of the Central Ural.

If nevertheless I think myself justified in considering the specimens from the Himálayan Productus shales as belonging to a distinct species, it is by reason of their particular sculpture, *viz.*, the presence of folds, which are certainly absent in the true ***Sp. Marcoui.***

*Locality, number of specimens examined.*—N. W. Kiunglung encamping ground, S. W. Niti Pass, 1; south of Dharma XI, Lissar Valley, Johár, 1.

*Remarks.*—Among the materials collected by Payer in the permocarboniferous rocks of the South Cape of Spitzbergen and described by F. Toula, which now belong to the collections of the Imperial Museum of Natural History in Vienna, there are two ventral valves, which must be attributed to ***Spirifer Marcoui.*** On the labels attached to them they are marked as ***Sp. Wilczeki***, Toula, but the true ***Sp. Wilczeki*** is a perfectly different species, as may be seen at once from a comparison of Waagen's type specimen of ***Sp. Marcoui*** with Toula's figure (Kohlenkalk-Fossilien von der Südspitze von Spitzbergen, Stzgsber. Kais. Akad. d. Wiss. Wien, 1873, Pl. I, fig. 3). In these Spitzbergen shells the deep sinus is not sharply impressed in the middle, but rounded, as is likewise frequently the case in ***Sp. Marcoui.*** They agree very well with the latter species, from which they only differ by their distinctly concave area, recalling in this respect my Himálayan ***Sp. Ravana.***

The large geographical distribution of forms, identical or very closely allied to ***Sp. Marcoui*** in beds of upper carboniferous, permocarboniferous and permian age is not without interest.

## *b.* GROUP OF SPIRIFER FASCIGER, Keyserling.

### 2. SPIRIFER MUSAKHELENSIS, Davidson, Pl. III, fig. 3, 4, Pl. IV, fig. 1 a, b, 2, Pl. V, fig. 1.

1862. ***Spirifer Moosakhailensis***, Davidson; Quart. Journ. Geol. Soc., London, XVIII, p. 28, Pl. II, fig. 2.

1863. ***Sp. Moosakhailensis***, (Dav.); L. de Koninck, Mémoire sur les fossiles paléozoiques, recueillis dans l'Inde, p. 34, Pl. XI, fig. 2.

1865. ***Sp. Moosakhailensis***, Beyrich; Über eine Kohlenkalk fauna von Timor, Abhandlgn. Königl. Akad. d. Wiss. Berlin, 1867, p. 77, Taf. I, fig. 7.

---

[1] *A. Bittner*,—Brachiopoden der alpinen Trias. Abhandlgn. k. k. geol. Reichs.-Anst. Wien, XIV, 1890, p. 22, Taf. XXXIV, fig. 1-28.

[2] Denkschr. Kais. Akad. d. Wiss. Wien, 1895, math. nat. Cl., LXII p. 568.

1865. *Sp. Moosakhailensis*, Stoliczka; Geological sections across the Himálayan Mountains, etc., Mem. Geol. Surv. of India, V, Pt. i, p. 27.
1866. *Sp. Moosakhailensis*, Davidson; Quart. Journ. Geol. Soc., London, XXII, p. 41, Pl. II, fig. .
1873. *Sp. striatus* (Mart.); Toula, *ex parte*, Kohlenkalk-Fossilien von der Südspitze von Spitzbergen Sitzgsber. Kais. Akad. d. Wiss. Wien, math.-nat. Cl., LXVIII, p. 270.
1881. *Sp. timorensis*, K. Martin; Die versteinerungsführenden Sedimente Timors, Sammlungen des Reichs Museums in Leyden, 1881-83, Bd. I. (Beiträge zur Geologie Ost.-Asiens und Australiens), p. 41, Taf. II, fig. 7, 8.
1883. *Sp. Musakheylensis*, Waagen; Salt Range Fossils, Pal. Indica, ser. xiii, I, Productus Limestone-Foss., p. 512, Pl. XLV.
1892. *Sp. fasciger* (Keyserl.); Schellwien, *ex parte*, Die Fauna des karnischen Fusulinenkalks I, Palæontographica, 39 Bd., p. 42, Taf. V, fig. 3, (*not* fig. 2).
1892. *Sp. Musakheylensis*, Rothpletz: Die Perm.-Trias und Jura-Formation auf Timor und Rotti, Palæontographica, 39 Bd., p. 79, Taf. IX, fig. 1, 2.

This is the commonest species of the genus *Spirifer* in the Productus shales of Kumaon and Gurhwal, but, strange to say, it is represented by ventral valves only in Griesbach's collection.

To Waagen's excellent description of ***Sp. musakhelensis*** I have but very little to add. Among my specimens the one figured Pl. IV, fig. 2, almost perfectly agrees with the typical form (Pl. XLV, fig. 1, 2 in Waagen's memoir). That the variability of the species is rather great, may be clearly seen from a comparison of the rest of my figures. In their chief characters, however, all my specimens agree pretty well among each other. As such characters, which permit a provisional distinction of ***Sp. musakhelensis*** from its nearest allies, I consider the presence of broad flatly rounded folds, each of which corresponds to a bundle of ribs, and the erect, lamellose condition of the striæ of growth. In all of my specimens, even if the shell appears to be perfectly well preserved, the ribs, though being of very different strength, are always more or less distinctly rounded on their tops, but never sharp. In the majority of my specimens the lamellose character of the striæ of growth is well exhibited. It is excellently developed in my largest specimen (Pl. V, fig. 1), whereas it is barely at all observable in the specimen figured on Pl. III, fig. 4. A character, which may be noticed in the majority of my specimens, is the presence of a median rib in the bottom of the sinus, which in strength slightly surpasses the neighbouring ones.

Much difference of opinion has been expressed, as to the specific value of ***Spirifer musakhelensis.*** Thus in 1889 it was placed by Tschernyschew (Mémoires du Comité Géol. de la Russie, St. Pétersbourg, Vol. III, No. 4, p. 366) among the synonyms of ***Sp. fasciger*** Keyserling. The same author added ***Sp. tegulatus,*** Trautschold (die Kalkbrüche von Miatschkowa, Moskau 1876, p. 80, Taf. VIII, fig. 6) to the synonyms of ***Sp. fasciger,*** whereas by the generality of palæontologists the three had hitherto been maintained as separate species.

Waagen considered the erect, lamellose condition of the striæ of growth as a specific character of the Indian shell and of ***Sp. tegulatus,*** supposing them to be constantly absent in ***Sp. fasciger.*** The figures giving by Count Keyserling's (Petschoraland p. 231, Taf. VIII, fig. 3, 3*a*, 3*b*), by whom the latter species had been introduced, represent either young or very imperfectly preserved specimens, from which no adequate idea of the species can be got. Neither he nor Gruenewaldt, who reproduced a figure of a better preserved though incomplete fragment,[1] mentioned in their descriptions of *Sp. fasciger* the presence of lamellose striæ of growth. Tschernyschew, however, who examined a large number of specimens, attributes the absence of a lamellose sculpture to their inferior state of preservation, stating explicitly that among his materials specimens with distinctly lamellose striæ of growth are frequent. According to his view even the peculiar sculpture in *Sp. tegulatus*, resembling a tiled roof, is only due to the excellent state of preservation of Trautschold's type specimen.

Nikitin (Mém. Com. géol. de la Russie, St. Pétersbourg 1890, Vol, V, No. 5, p. 164) and Schellwien[2] coincide with Tschernyschew in the belief, that *Sp. tegulatus* and *Sp. musakhelensis* are nothing more than different states of *Sp. fasciger*, in which the shell has attained a more or less strongly marked lamellose condition. On the other hand Rothpletz (Palæontographica, *loc. cit.* p. 9), who cannot be considered an advocate of a very narrow circumscription of the single species, did not dare to unite *Sp. fasciger* and *Sp. musakhelensis*, observing that the sharp folds in the ornamentation of the Russian species might constitute a specific character of difference.

Notwithstanding Tschernyschew's and Schellwien's contrary opinions, I have made use of Davidson's name for my Himálayan shells.

If we set aside the lamellose character of the striæ of growth, there still remains as a distinguishing feature the character of the folds corresponding to the fasciculi of ribs. Grünewaldt states, that in his specimen of *Sp. fasciger* from Ssaraninsk these folds are roof-shaped, with acute edges. In Tschernyschew's figure (Pl. V, fig. 4) this acute character of the folds imparts to the front margin the shape of an angular zig-zag bent line, whereas in *Sp. musakhelensis* the folds are always rounded, at least in full grown individuals. Nor do any of the Himálayan shells absolutely agree with Tschernyschew's figure regarding the character of the minor ribs, which appear to be of a more acute shape in the Artinskian specimen.

I am well aware that very different opinions may be expressed, relative to the specific value of the characters mentioned. Without denying the possibility of Tschernyschew's view being the more correct, I may only remark, that, by following his opinion, we should obtain a very variable species. Nor should we be justified in retaining *Sp. poststriatus*, Nikitin (*loc. cit.* p. 167, Taf. II, fig. 16-19) as a distinct species. *Sp. poststriatus* differs from *Sp. fasciger*, only by the flattening of its ribs in the lower portion of the shell. A comparison of Nikitin's figures with illustrations of *Sp. fasciger* and of *Sp. tegulatus* will show at a glance, that the differences between the two latter species are the more conspicuous. It might even be taken into consideration, whether *Sp. cameratus*, Morton, and its American allies ought not be united with *Sp. fasciger*, which they certainly most nearly approach.

---

[1] M. v. *Gruenewaldt*, Beiträge zur Kenntniss der sedimentären Gebirgsformationen in den Berghauptmannschaften Jekatherinburg, Slatoust etc., Mém. Acad. impér. des sciences, St. Pétersbourg 1860, sér. vii, II, No. 7, p. 97, Taf. V, fig. 1.

[2] Die Fauna des Karnischen Fusulinenkalks l. c. p. 42, and: Ueber eine angebliche Kohlenkalk-fauna aus der aegyptisch-arabischen Wüste. Zeitschr. Deutsch. Geol. Ges. 1894, XLVI, p. 72.

In this case a species is obtained, including a multitude of types, to which, of course, varietal denominations will presently be applied. Later on these varietal denominations will probably be developed once more into specific ones, disputes as to priority following almost certainly the re-introduction of the former species. I consequently deemed it more practical to retain the original separate denominations for such forms, as long as they can actually be distinguished. If I apply the name *Spirifer musakhelensis* to my Himálayan specimens, every palæontologist will know at once that neither forms with the particular sculpture of *Sp. tegulatus*, nor any agreeing with Grünewaldt's and Tschernyschew's figures of *Sp. fasciger* are present among them.[1]

I have been confirmed in my view of this subject by an examination of Schellwien's type specimens of his *Sp. fasciger* (*loc. cit.* Pl. V, fig. 2, 3), from Carinthia, which I have been enabled to study by the kindness of Professor Edward Suess, to whose collection they belong. As has been justly remarked by Schellwien himself, one of these two specimens absolutely agrees with Trautschold's *Sp. tegulatus* whereas the second resembles more closely *Sp. musakhelensis*. I may add from my personal examination that the two specimens differ from each other more strongly than appears from their figures, and that I would not have thought of uniting them in one and the same species without Prof. Tschernyschew's authority supporting their identification. I consequently retain the Indian denomination for the Carnian specimen, figured on Pl. V, fig. 3, of Schellwien's memoir.

The measurements of some of my specimens prove that the species can attain even larger dimensions than had been supposed by Davidson and Waagen. In my largest specimen (Pl. V, fig. 1) the breadth of the shell is scarcely less than 110 mm.

The measurements of my most complete ventral valve (Pl. IV, fig. 2) are as follows:—

| | |
|---|---|
| Entire length of the shell . . . . . . . . . | app. 38 mm. |
| Greatest breadth of the shell . . . . . . . . . | app. 80 „ |
| Apical angle of the ventral valve . . . . . . . | 125°. „ |

*Locality, number of specimens examined.*—N.W. Kiunglung encamping ground, S.W. Niti Pass, 6; S. of Dharma XI, Lissar Valley, 1.

*Remarks.*—*Spirifer musakhelensis* is a species of a rather wide geographical and geological distribution. In the Salt Range it extends, according to Waagen, through the entire thickness of the Productus limestone, although it is most common in the middle division of this rock system. Davidson obtained it from the Barus beds in Kashmir (upper carboniferous), Stoliczka from his Kuling series in Spiti, Beyrich and Rothpletz from the permian rocks of the island of Timor.[2] Prof. Suess collected the species in the upper carboniferous Fusulina limestone of the Carnian Alps in Carinthia.

---

[1] I am glad to state, that Dr. Bittner quite recently took exactly the same view of this matter in a similar case. Lamellibranchiaten der alpinen Trias. I. Th. Revision der Lamellibranchiaten von St. Cassian, Abhandlgn. K. K. geol. Reichs. Anst. Wien. XVII, Heft. 1. 1895, p. 97).

[2] I fully agree with Professor Rothpletz in refusing to *Sp. timorensis* a separate specific value. The specimens from Ajer Mati are far from presenting so peculiar a type, as has been assumed by K. Martin.

Among the specimens, collected by Payer at the South Cape of Spitzbergen, and identified by Toula with *Sp. striatus*, there is one, which very nearly agrees with my specimen of *Sp. musakhelensis* from Kiunglung, figured on Pl. IV, fig. 1. Although it is more strongly weathered than the latter, it distinctly shows the bundling of the ribs, which is not confined to the apical region only, as in *Sp. striatus var. attenuatus* (Sow.) Davidson (British carboniferous Brachiopoda, Pl. II, fig. 12, 13) or in *Sp. condor*, d'Orbigny (Voyage dans l'Amérique méridionale, III, Paléontologie, 1842, p. 46, Pl. V, fig. 11—14). On the contrary, like in the true *Sp. musakhelensis*, the ribs in each bundle are more and more augmented by bifurcation, as the bundle approaches the margins of the valve. Near the front margins a few lamellose striæ of growth could be noticed. I have consequently placed this specimen among my list of synonyms of the present species.

In America the group of *Sp. fasciger* is represented by *Sp. cameratus*, Mort., and its allies. Owen considered *Sp. cameratus* (Geological Survey of Wisconsin, Iowa and Minnesota, 1852, Pl. V, fig. 4) from the coal measures of North America as a synonym of *Sp. fasciger;* Geinitz (Carbonformation und Dyas in Nebraska, p. 44) and Tschernyschew take a similar view of this question. Nikitin supposes that *Sp. cameratus* may more probably prove to be identical with *Sp. poststriatus*. Schellwien leaves the question of identity undecided, laying, however, a special stress on the description of *Sp. cameratus* by Meek and Hayden (Final Report of the U. S. Geol. Surv. of Nebraska, p. 183), who explicitly state the absence of any lamellose striæ of growth in their American species.

The Brazilian forms of *Sp. cameratus*, as described by O. A. Derby (on the carboniferous brachiopoda of Itaituba, Bull. of the Cornell University, Ithaca, I, 1874, p. 12) are partly provided with raised lamellose striæ of growth, but differ from *Sp. musakhelensis* in the considerably less distinct bundling of their ribs, and by the absence of any well marked folds in the sculpture of the shells.

*Sp. condor* d'Orb., which E. de Verneuil and Davidson identified with *Sp. striatus var. attenuatus*, Sow., is added by Derby to his list of synonyms of *Sp. cameratus*. The nearly entire absence of the bundling of the ribs make this species indeed most nearly approach to the Brazilian *Sp. cameratus*. *Sp. striatus var. multicostatus* Toula (Ueber einige Fossilien des Kohlenkalkes von Bolivia, Sitzgsber. Kais. Akad. d. Wiss. LIX, Bd. 1869, p. 435, Taf. I, fig. 2—4) from the upper coal measures of Cochabamba is likewise placed by Derby among the synonyms of *Sp. cameratus*. Although this view has met with the approval of Schellwien (Zeitschr. Deutsch. Geol. Ges., 1894, p. 72) I am not convinced of the identity of the two species, as Toula's type specimen (fig. 2) is provided with a sharply impressed sinus, which seems to remain angular up to the front margin. A *Spirifer* from Cochabamba among the collections of the Imperial Museum of Natural History in Vienna, which I have been able to examine, approaches most nearly *Sp. poststriatus*, Nikitin.

A species from Axel Island (Spitzbergen), which Toula united with *Sp. cameratus* under a varietal denomination (Permo-Carbon-Fossilien von der Westküste von Spitzbergen, Neues Jahrb. f. Mineral. 1875, p. 270, Taf. II, fig. 3), must be separated from Morton's species on account of its very strong folds, each of which is composed of a small number of ribs only. This interesting species might eventually prove an intermediate link between the groups of ***Sp. fasciger*** and ***Sp. niger***, Waagen (*loc. cit.* p. 522, Pl. XLVIII, fig. 4—6).

***Sp. cameratus***, Toula (Eine Kohlenkalk-fauna von den Barents Inseln, Sitzgsber Kais. Akad. d. Wiss. Wien, LXXI, 1875, p. 17, Taf. II. fig. 2) from Barents Island (N.W. Nowaja Semlja) will probably have to be united with either ***Sp. poststriatus*** or ***Sp. fasciger***.

### 3. SPIRIFER SP. AFF. FASCIGERO, Keyserling, Pl. V, fig. 2, 3.

This species is but very imperfectly known to me, being represented in Griesbach's Himálayan collection by a solitary incomplete dorsal valve. Nevertheless I do not dare to identify the specimen under consideration with either ***Sp. fasciger*** or ***Sp. musakheylensis***, as it deviates from them in certain peculiarities and may perhaps belong to a different species.

The most characteristic feature in the sculpture of this valve is the large number of acute ribs, arranged into fasciculi and gradually augmenting in strength, as they approach the front margin. This is just the reverse of what one is accustomed to see in the ornamentation of ***Sp. fasciger*** and of ***Sp. musakhelensis*** in which the ribs are, as a rule, strongest in the vicinity of the apical region. The ribs corresponding to the median line of each bundle, are more prominent than the rest, roof shaped in their transverse section, and provided with sharp edges. They are not straight nor do they describe a regular curve but are flexuous and, near the hinge-line, even form zig-zag bent or wavy lines. Lines of growth are clearly marked, but do not form distinctly raised lamellæ. The apex projects but very little above the hinge line.

The present incomplete valve must belong to a very large specimen, its greatest breadth being about 105 mm.

To this species I attribute provisionally the fragment of a dorsal valve figured Pl. V, fig. 3, comprising a part of its median fold or varix. This median fold projects very strongly and is pointed into a sharp, knife-like edge.

Although in its general shape and sculpture my type specimen agrees with ***Sp. fasciger***, Keyserl.,[1] it seems at least probable, that a different species is indicated by this specimen, standing to the true ***Sp. fasciger*** in a similar relationship, as ***Sp. poststriatus***, Nikitin (Mém. Com. Géol. de la Russie, St. Pétersbourg, 1890, V, No. 5, p. 164, Tab. II, fig. 16—19). Whereas this latter species differs from ***Sp. fasciger*** especially by the flattening of its ribs in the vicinity of the margins, my Himálayan specimen is distinguished by their being less strongly marked in the vicinity of the apical region. The differences are, however, but very small, and with larger materials for comparison available, the present species may turn out to be only a variety of the true *Sp. fasciger*. Nor am I inclined to assign to the specimen under consideration any proper specific designation.

---

[1] ***Graf Keyserling***, Wissenschaftliche Beobachtungen auf einer Reise in das Petschoraland, p. 231, Taf. VIII, fig. 3, 3 a, 3 b; ***M. v. Grünewaldt***, Beiträge zur Kenntniss der sedimentären Gebirgsformationen etc., Mém. Acad. imp. des sciences, St. Pétersbourg, 1860, sér. vii, II, No. 7, p. 97, Taf. V, fig. 1; ***Th. Tschernyschew***. Mém. Com. Géol. de la Russie, St. Pétersbourg, 1889, III No. 4, p. 366, Taf. V, fig. 4.

***Locality, number of specimens examined.***—N. W. Kiunglung encamping ground, S. W. Niti Pass, 2 (?).

### 4. SPIRIFER NITIENSIS, nov. sp. Pl. IV, fig. 4, 5 a—e.

This remarkable species belongs to the relationship of ***Sp. musakhelensis*** from which it may however be easily distinguished by some very conspicuous peculiarities. With ***Sp. musakhelensis*** it has in common the arrangement of the ribs into fasciculi, imparting a wavy character to the surface of the shell, the lamellose condition of the erect lines of growth, the high apex of the dorsal valve, which is protracted into a very prominent median fold towards the front and corresponds to the deep sinus of the ventral valve.

Peculiar to the present species is its fusiform shape, recalling ***Sp. convolutus***, Phill., among the carboniferous ***Spiriferidæ***. Although in none of my specimens are the wings completely preserved, it can be easily understood from their restoration in the figure (5 a ) that the breadth of the shell must have been more than three times its length. The ventral valve is strongly curved in the longitudinal but nearly in the transverse direction. Its area is tolerably broad, strongly reclining, parallel-sided, and shows a distinct vertical striation. The striæ are rather broad, neither prominent nor straight, but wavy. The triangular fissure is covered up by the rocky matrix in both of my type specimens. The beak is small, short, pointed, and but slightly produced beyond the cardinal edge. By the rounded, strongly protracted sinus the front margin of the dorsal valve is considerably elevated above the general convexity of the latter.

The radial ornamentation, although characterised in general by an arrangement into fasciculi, differs considerably from the sculpture peculiar to ***Sp. musakhelensis***, ***Sp. fasciger*** and their allies. The number of fasciculi is considerably larger, about ten on each side of the sinus, but the number of ribs composing each bundle is rarely more than three or four, and the augmentation of ribs by bifurcation ceases at an earlier stage of growth than in ***Sp. musakhelensis***. The most important difference from the latter species consists however in the unequal strength of the ribs. In the three fasciculi, which follow immediately on either side of the sinus, the central rib is always considerably broader and stronger than the rest, whereas on the proper wings they are formed of more delicate ribs of equal strength and width. In the bottom of the sinus a broad median rib is noticed, bordered on each side by two more delicate ones. All the ribs are flatly rounded on their tops.

The lamellose condition of the raised striæ of growth is pretty well exhibited in both of my specimens.

The dorsal valve is provided with a very high, narrowly rounded, mesial fold, rising from the very apex of the valve, and being most prominent at the front margin. To the meeting of this mesial fold with the corresponding sinus of the ventral valve the strong frontal wave is due, which is observable in the type specimen.

The apex projects more strongly above the hinge line, than in *Sp. musakheylensis*. The area is distinctly marked, though of very small size. The ornamentation agrees with that in the ventral valve.

The measurements of the more complete of my two specimens are as follows:—

| | |
|---|---|
| Entire length of the shell . . . . . . . . . | 30 mm. |
| Length of the dorsal valve . . . . . . . . . | 24 „ |
| Greatest breadth of the shell . . . . . . . . . | 105 „ |
| Thickness of both valves . . . . . . . . . . | 18 „ |
| Breadth of the area of the ventral valve . . . . . . . | 6 „ |
| Apical angle of the ventral valve . . . . . . . . | 144° |
| „ „ „ „ dorsal valve . . . . . . . . . | 139° |

*Locality, number of specimens examined.*—N. W. Kiunglung encamping ground, S. W. Niti Pass, 2.

*Remarks.*—The present species is very markedly distinct from the remaining forms belonging to the group of *Sp. fasciger*, by its transversely fusiform shape, and by its peculiar sculpture. I am not aware of any species of the former group, to which in this respect it could be more particularly compared. With regard to the latter characters it somewhat approaches *Sp. niger*, Waagen (Salt Range Fossils *loc. cit.* p. 522, Pl. XLVIII, fig. 4—6) from the lower Productus limestone of the Salt Range. With this species the present one has in common the general shape, the prominent rib in the middle of the sinus, and the arrangement of ribs of unequal strength into fasciculi. In *Sp. niger*, however, the principal ribs are much broader and stronger and a small number of thin radial ribs are arranged into distinct bundles. Both in *Sp. niger* and in its European ally, *Sp. alatus*, Schloth., the median fold of the dorsal valve is perfectly smooth, whereas it is covered by radiating ribs in *Sp. nitiensis*.

On the whole the present species seems to be less nearly related to the group of *Sp. alatus*, than to that of *Sp. fasciger*. I have consequently deemed it preferable to leave it among the latter.

### *c.* GROUP OF SPIRIFER CONVOLUTUS, Phill.

### 5. SPIRIFER JOHARENSIS, nov. sp. Pl. IV, fig. 3.

This very interesting species seems to hold an intermediate position between *Sp. convolutus*, Phill.[1] and *Sp. niger*, Waagen (Salt Range Fossils, Pal. Indica, ser. xiii, I, Prod. Limest. Foss. p. 522, Pl. XLVIII, fig. 4—6), which is supposed by Waagen to be most nearly related to the permian *Sp. alatus*, Schloth.

---

[1] *Davidson*, Monograph British fossil Brachiopoda p. 35. Pl. V, fig. 2—15; *L. de Koninck*, Faune du calcaire carbonifère de la Belgique. Annales du Musée Royal d'hist. nat. de Belgique, XIV, 6ème ptie., p. 127, Pl. XXIX, fig. 4—6.

The only well preserved specimen of this species in the Himálayan collection strongly recalls *Sp. niger* in its general outline. It is transversely fusiform, more than twice as broad as long, provided with a prominent median fold in the dorsal and corresponding sinus in the ventral valve. The valves are moderately convex, the dorsal valve being a little more strongly vaulted than the opposite one.

The ventral valve is provided with a tolerably broad, concave area, bordered by nearly parallel margins. The extremities of the wings being broken off in my type specimen, it cannot be decided, whether they have been regularly curved or attenuated towards the cardinal angles. The beak is small, well incurved, but not very prominent. The apical angle is comparatively acute, as in *Sp. niger*. The deep and broadly rounded sinus originates in the very apex and is considerably prolonged beyond the frontal level of the lateral portions of the valve. The sinus is divided by five very delicate ribs, among which the central one is but slightly larger and more extended than the rest. On either side of the sinus the lateral parts of the valve are ornamented by six thick, rounded ribs, each of which is either subdivided into smaller ones by bifurcation, or is accompanied by two or three indistinct, intercalated costæ. There are also faintly marked traces of a concentric sculpture, consisting of regular, imbricating laminæ of growth.

The dorsal valve is characterised by its very obtuse apical angle, and its elevated median fold, which becomes subdivided into four smaller ones in the vicinity of the front. On each side of this rounded median fold there are five or six thick radial ribs, each of which is accompanied by intercalated or dichotomous smaller ones. The sculpture on either side of the median fold is not perfectly symmetrical. In this valve the concentric ornamentation is better developed than in the ventral one.

The measurements of my type specimen are as follows :—

| | | |
|---|---|---|
| Entire length of the shell . . . . . . . . . | 17·5 | mm. |
| Length of the dorsal valve . . . . . . . . . | 14 | „ |
| Entire breadth of the shell . . . . . . . . . | 40—75 | „ |
| Thickness of both valves . . . . . . . . . | 9 | „ |
| Apical angle of the ventral valve . . . . . . . . | 118° | |
| „ „ „ „ dorsal „ . . . . . . . . | 140° | |

*Locality, number of specimens examined.*—S. of Dharma XI, Lissar Valley, one complete specimen, besides a small number of fragments, which probably belong to this species.

*Remarks.*—The two species, to which the present one seems to be most nearly related, are ***Sp. convolutus***, Phill., and ***Sp. niger***, Waagen. With both of them ***Sp. joharensis*** has in common the general shape, the strongly elevated median fold in the dorsal valve, and the strong frontal wave, which is due to the extending of the sinus in the ventral valve beyond the frontal level of the lateral portions.

The ornamentation is very much like that in *Sp. niger*. From this species ***Sp. joharensis***, however, differs by the absence of a strong, prominent, median rib in the sinus and by the character of the median fold in the dorsal valve, which is smooth in *Sp. niger* and does not become subdivided into minor ribs. With regard to these characters our species agrees with ***Sp. convolutus***, but on the other hand their sculpture is sufficiently different to make a distinction between them an easy matter. Although in *Sp. convolutus* a bifurcation or intercalation of ribs frequently takes place, an ornamentation similar to that in my type specimen of *Sp. joharensis* is never produced.

On the whole I believe the present species to be about intermediate between *Sp. convolutus* and *Sp. niger*.

*Spirifera convoluta* (?), Etheridge, (Description of the palæozoic and mesozoic fossils from Queensland, Quart. Journ. Geol. Soc., London, 1872, XXVIII, p. 335, Pl. XVII, fig. 3,) from the Bowen River coalfield in Queensland may perhaps hold a similar intermediate position between *Sp. joharensis* and Phillips' species.

### *d*. Group INDET.

### 6. Spirifer sp. indet. Pl. IV, fig. 6.

I should not have mentioned this fragment of a *Spirifer* from the Productus shales of Kiunglung encamping ground, were it not for its extraordinary shape. It is provided with an unusually broad, slightly concave area, divided by an enormous triangular fissure. The beak is small, bent over, and pointed. A deep sinus takes its origin in the apex and is bordered by strong ribs. The shell is distinctly fibrous, not punctuated. There can therefore be no doubt that this species belongs to the genus *Spirifer*.

## Subfamily: MARTINIINÆ, Waagen.

## Genus: MARTINIA, M'Coy.

### 1. Martinia glabra, Martin, sp. Pl. V, fig. 4 a, b, c, d.

1809. *Conchyliolithes Anomites glaber*, Martin. Petrif. Derb, p. 11. Pl. XLVIII, fig. 9. 10.
1843. *Spirifer glaber* (Mart.) L. de Koninck. Description des animaux fossiles, etc. Liége, p. 267. Pl. XVIII, fig. 1.
1859. *Spirifera glabra* (Mart.) Davidson, Monograph British Carbon. Brach., p. 59, Pl. XI, fig. 1—9, Pl. XII, fig. 1—5, 11, 12.
1873. *Spirifer glaber* (Mart.) L. de Koninck, Monographie des fossiles carbonifères de Bleiberg, p. 57, where a complete list of synonyms is given.
1883. *Martinia* cf. *glabra*, Waagen, Salt Range fossils, Pal. Ind. ser. xiii, I, Prod. Limest. Foss. p. 531.

The genus (or subgenus?) *Martinia* is represented in Griesbach's Himálayan collection by one single but well preserved specimen. It agrees in general with the well known carboniferous species *M. glabra*, but its identification with the latter is not beyond every doubt, as it differs from the typical *M. glabra* by its shorter hinge line, recalling in this respect the group of *M. Warthi*, Waagen.

My specimen is transversely oval, a little wider than long, provided with almost equally convex valves. The hinge line is a little shorter than one third of the greatest breadth of the shell. The ventral valve is somewhat more strongly curved than the dorsal one. Its prominent apex is distinctly incurved. The area is small and bordered by well defined lateral margins. Its greater portion is filled up by the triangular fissure. The sinus is strongly marked, originating in the very apex, and causes the frontal part of the valve to be slightly produced. The surface is nearly smooth, and interrupted only by a few, delicate striæ of growth.

In the dorsal valve a strongly marked mesial fold is developed, rising gradually from the lateral portions. Besides the lines of growth, there are faint indications of a few radial striæ on this valve, whose surface is otherwise smooth.

The measurements of my specimen are as follows :—

| | | |
|---|---|---|
| Entire length of the shell | 16 | mm. |
| Length of the dorsal valve | 13 | „ |
| Entire breadth of the shell | 18·5 | „ |
| Length of the hinge-line | 6 | „ |
| Thickness of both valves | 10 | „ |
| Apical angle of the ventral valve | 97° | |
| „ „ „ „ dorsal „ | app. 130° | |

*Locality, number of specimens examined.*—N. W. Kiunglung encamping ground, S. W. Niti Pass, 1.

*Remarks.*—The only character, in which my specimen slightly differs from the typical ***Martinia glabra***, is its shorter hinge line. Davidson however expressly remarks, "that the length of the hinge line and area in many indubitable specimens of *Spirifera glabra* is not more than a third of the breadth of the shell." Waagen on the contrary, lays a special stress on the length of the hinge line, when identifying one of his specimens from the lower Productus limestone with *M. glabra* stating "that it chiefly agrees with *M. glabra* in the comparative length of the hinge line, which is not very much shorter than the greatest breadth of the shell." He moreover places the Salt Range species of the genus *Martinia*, which are distinguished by a short hinge line, in a separate section, *viz.*, the group of *M. Warthi*. According to his observations this series of forms "is distinct from the typical *M. glabra* by a much shorter hinge line, which terminates on both sides in little wings, and by the circumstance that the sinus of the ventral valve is entirely limited to the frontal region." (*loc. cit. p.* 530). As my specimen has in common with *M. Warthi* only the short hinge line, but none of the other characters enumerated by Waagen, I deemed it preferable to assign it to Martin's species, following Davidson's opinion, who does not think the comparatively long hinge line to be a constant character in *M. glabra*.

*M. glabra* is one of the most abundant of carboniferous fossils. Although it is commonest in the mountain limestone of lower carboniferous age, its geological distribution is rather wide. It has been found throughout the carboniferous series of the Ural, in the Moscovian stage of Central Russia, in the upper carboniferous Fusulina limestone of Carinthia, in the Chester stage of Illinois,[2] and in the

---

[1] 13 mm. corresponding to a breadth of the shell of 18·5 mm.

[2] *M. glabra var. contracta*. Meek. and Worthen; Geol. Survey of Illinois. Vol. II. Palæontology, 1866, p. 298

lower Productus limestone of the Salt Range. On the other hand, Davidson mentions specimens from the Devonian rocks of Barton, " which appear undistinguishable from some from the carboniferous limestone.

No importance can therefore be attributed to its occurrence in the permian Productus shales of the Himálayas.

## Family: *ATHYRIDÆ*, Phillips.

## Subfamily: ATHYRINÆ, Waagen.

### Genus: SPIRIGERELLA, Waagen.

### 1. Spirigerella derbyi, Waagen. Pl. V, fig. 6, a—d, 8 a—c.

1862. *Athyris subtilita* (Hall), Davidson,—Quart. Journ. Geol. Soc. London, XVIII, p. 28, Pl. I, fig. 8 (not fig. 7, non Hall).

1863. *Athyris subtilita* (Hall) L. de Koninck,—Mémoire sur les fossiles paléozoiques, recueillis dans l'Inde, p. 33, Pl. IX, fig. 8.

1867. *Athyris sp.* (*Athyris subtilita*, Hall) Verchère,—Kashmir, the Western Himálaya, and the Afghan Mountains, Journ. Asiatic Soc. of Bengal, XXXVI, Pt. ii, p. 210, Pl. II, fig. 1, 1 a.

1874. *Athyris subtilita* (Hall) ?—Derby *pro parte*, On the carboniferous brachiopoda of Itaitúba, Bull. Cornell. Univers. Ithaca, I, No. 2, p. 7, Pl. I, fig. 7.

1884. *Spirigerella Derbyi*, Waagen,—Salt Range Fossils, Pal. Indica, ser. xiii, I, Prod. Limest. Fossils, p. 453, Pl. XXXV, fig. 4—7, 9—13, Pl. XXXVI, fig. 11—13, var. *acuteplicata*, p. 456, Pl. XXXV, fig. 10-11, Pl. XXXVII, fig. 11.

This species is the most common fossil of the Productus shales near Kiunglung encamping ground, where slabs of rock are made up almost entirely of its shells.

My specimens agree with Waagen's species in all their essential characters. Among Waagen's types they most nearly approach the one figured on Pl. XXXV, fig. 11, and described under the varietal denomination of *acuteplicata*. The Himálayan specimens exhibit well the generic peculiarity, which induced Waagen to separate *Spirigerella* from *Athyris*. The beak is entirely appressed to the apex of the dorsal valve, and the small foramen is therefore completely concealed.

My specimens do not vary so much in shape and dimensions, as the representatives of our species in the Salt Range. They are, as a rule, nearly as long as broad, but none of them exceeds 20 mm. in breadth. The ventral valve is distinctly curved in the longitudinal, but very little in the transverse direction, whereas the dorsal valve exhibits a strongly marked, but unequal transverse curvature with a distinct median crest. The sinus in the ventral valve originates quite near the apex, but is very narrow in the visceral portion of the valve, and only widens out in the tongue shaped process, which corresponds to the steeply vaulted frontal wave. It causes the dorsal valve to ascend in the prominent narrow fold, which imparts to *Sp. Derbyi var. acuteplicata* its characteristic feature.

Strong, imbricating striæ of growth are present at irregular distances. In later stages of growth the shelly zones marked off by them are of considerably different breadth in the lateral and frontal regions, as has been noticed by Waagen in his types from the Salt Range.

I am not able to distinguish specifically between my Himálayan shells and *Sp. Derbyi var. acuteplicata.* I am confirmed in this view by Professor Waagen, who believes them likewise to be identical.

The dimensions of a full grown specimen are as follow :—

| | |
|---|---|
| Entire length of the shell | 16·5 mm. |
| Length of the dorsal valve | 14 „ |
| Entire breadth of the shell | 17·5 „ |
| Thickness of both valves | 10 „ |
| Apical angle of the larger valve | 108° |
| „ „ „ „ smaller „ | 118° |

*Locality, number of specimens examined.*—N. W. Kiunglung encamping ground, S.W. Niti Pass, 10.

*Remarks.*—In the Salt Range *Sp. Derbyi* is very common both in the middle and upper divisions of the Productus limestone, but does not descend into the Katta beds, forming the base of the middle Productus limestone. In America it is represented among Derby's collections from the Itaitúba coalmeasures, which Waagen is inclined to place on a level with the upper division of the middle Productus limestone (Kalabágh beds).

## Genus: ATHYRIS M'Coy (SPIRIGERA, d'Orb.)

### 1. ATHYRIS ROYSSII, Leveillé, sp. Pl. V, fig. 5 a, b, fig. 7 a—d.

1862. *Athyris Royssii*, Davidson,—Quart. Journ. Geol. Soc., London, XVIII, p. 27, Pl. I, fig. 6.
1863. *Athyris Royssii*, L. de Koninck,—Mém. sur les fossiles paléozoiques recueillis dans l'Inde, p. 33, Pl. IX, fig. 6.
1865. *Athyris Royssii*, Salter,—Palæontology of Niti, etc., p. 53, Pl. V, fig. 13.
1865. *Spirigera Royssii*, Beyrich,—Ueber eine Kohlenkalkfauna von Timor, Abhandlgn. Königl. Akad. Wiss. Berlin, 1864, p. 74, Taf. I, fig. 3 (not 2).
1883. *Athyris Royssii*, Waagen,—Salt Range Fossils, Pal. Indica, ser. xiii, I, Prod. Limest. Foss. p. 457, Pl. XL, fig. 6—12, Pl. XXXIX, fig. 10.

I have given here only the quotations of the Indian and Australasian synonyms to the present species in order to show at once, what I wish to imply by the name.

According to L. de Koninck (Faune du calcaire carbonifère de la Belgique, Annales du Musée Royal d'hist. nat. Bruxelles, 1887, T. XIV, 6è me Ptie., p. 85) all the shells from upper carboniferous and permian strata, which have been classed by palæontologists among the synonyms of *A. Royssii*, are not identical with Leveillé's species from the mountain limestone. Without venturing to give any view on this subject, I shall confine myself to the statement, that shells identical with such as have been located by the above-mentioned authors within the synonyms of *A. Royssii*, are common among the fossils of the Himálayan Productus shales.

The majority of my specimens agree almost perfectly with Waagen's types in their outlines and sculpture. Among them the specimen Pl. V, fig. 5, may be taken as prototype, whereas, the small specimen, figured Pl. V, fig. 7, with its pentagonal outlines shows some difference, but is linked to the former by a large number of intermediate forms. The curvature in the two valves is either equally strong or the dorsal valve is more strongly vaulted than the ventral one. A small sinus is, as a rule, present in the larger valve corresponding to a more or less distinctly developed median fold in the opposite valve. A flat frontal wave is always present. The foramen in the beak is comparatively small.

The ornamentation of the shell is best exhibited in my largest specimen although it is but partially preserved. It consists of very numerous and thin, lamellar, concentric striæ of growth, of which 20 to 25 are counted to a space of 10 millimetres. Shelly fringes have not been noticed. The interior cast of the ventral valve is covered by distinct radial striations.

The measurements of the two figured specimens are as follow :—

| | I. | II. |
|---|---|---|
| Entire length of the shell | 39 mm. | 17·5 mm. |
| Length of the dorsal valve | ? | 16 „ |
| Entire breadth of the shell | 41 mm. | 20 „ |
| Thickness of both valves | app. 16 „ | 9 „ |
| Apical angle of the ventral valve | 130° | 100° |
| „ „ „ „ dorsal „ | ? | 115° |

No. I is the largest specimen in Griesbach's collection, but is not completely preserved.

No. II represents the average size of the specimens occurring in the Productus shales of the Himálayas.

*Locality, number of specimens examined.*—N. W. Kiunglung encamping ground, S. W. Niti Pass, 8, S. of Dharma XI, Lissar valley, 1.

*Remarks.*—The Indian representative of *A. Royssii* is not restricted to any distinct geological horizon. In the Salt Range it seems to extend through the entire thickness of the Productus limestone formation. It has been mentioned by Beyrich and Rothpletz from the permian rocks of Timor. From the Himálayas it has been quoted by Salter from the Productus shales of the Niti district, by Waagen from a white crinoid limestone, which Mr. Hughes picked up somewhere in the mountain range to the north of Milam,[1] by Griesbach[2] from the red crinoid limestone, corresponding to the lower division of the carboniferous system in Kumaon and Gurhwal.

### Suborder: ANCYLOPEGMATA, Zittel.

### Family: *TEREBRATULIDÆ*, King.

### Genus: DIELASMA, King.

### 1. DIELASMA SP. IND, Pl. III, fig. 5, 5 b.

I have mentioned this poorly preserved fragment only in order to prove, that the genus *Dielasma* is represented among the fossils of the Productus shales in the vicinity of Kiunglung encamping ground. Every one, who is acquainted with the difficulty of determining complete specimens of *Dielasma*, will understand the reasons which induce me to abstain from identifying the fragment under consideration with any of the hitherto described species of this genus. Its similarity to *D. Hochstetteri*, Toula (Ueber einige Fossilien des Kohlenkalkes von Bolivia, Sitzgsber. Kais. Akad. Wiss. Wien, 1869, LIX Bd., Sep. Abdr. p. 2, fig. 1) from the coal-measures of Cochabamba may, however, be noticed. They agree in the general outlines of their shells, the greatest breadth of which is shifted towards the semicircular front margin, and in the elevated marginal region of the ventral valve.

---

[1] *T. W. Hughes* and *W. Waagen* Note on a trip over the Milam Pass, Kumaon. Records Geol. Surv. of India, XI, 1878, p. 182—187.

[2] *C. L. Griesbach*; Geology of the Central Himálayas, *l. c.* p. 120.

## CONCLUSIONS.

The marine fauna of the Productus shales of Kumaon and Gurhwal is composed of the following species, which have been described in the previous chapter :—

### CEPHALOPODA.

1. *Orthoceras sp. ind.*

### LAMELLIBRANCHIATA.

2. *Aviculopecten hiemalis* Salter.

### BRACHIOPODA.

3. *Chonetes Vishnu*, Salter.
4. ,, *lissarensis*, nov. sp.
5. *Productus Purdoni*, Dav.
6. ,, *gangeticus*, nov. sp.
7. ,, *cf. serialis*, Waag.
8. ,, *cf. Cancrini*, Vern.
9. ,, *cancriniformis*, Tschern.
10. *Spirifer Ravana*, nov. sp.
11. ,, *musakhelensis*, Dav.
12. ,, *aff. fascigero*, Keys.
13. ,, *nitiensis*, nov. sp.
14. ,, *joharensis*, nov. sp.
15. ,, *sp. ind.*
16. *Martinia glabra*, Mart. sp.
17. *Spirigerella Derbyi*, Waag.
18. *Athyris Royssii*, Lev. sp.
19. *Dielasma*, sp. ind.

Among these 19 species 3 are represented by fragmentary specimens only, which do not allow of any specific determination. Excluding these 3 species which belong to the genera *Orthoceras*, *Spirifer* and *Dielasma*, 16 species remain which impart to the fauna of the Productus shales their peculiar aspect. Among them 6 are new to science and 8 only can be identified with such species as have been hitherto found outside the Himálayas. There is, however, still a large number of fragments in Griesbach's collection, which must remain undetermined, but which clearly prove, that our knowledge of the present fauna is yet very imperfect.

The fauna of the Productus shales shows quite a peculiar character of its own, as more than half of the entire fauna is composed of species which have not hitherto been found in any other rock groups. It must be borne in mind, that out of the 3 forms described in the previous chapter, which do not allow a specific determination, 2 at least are certainly new. Thus out of a total number of 19 species 10 are restricted exclusively to the Productus shales.

Whilst the majority of species are autochtonous, the remaining forms—altogether 8—are identical with such as occur also in the younger palæozoic strata of other countries. Among the latter, the following six are identical with species which have been described by Waagen from the Productus limestone of the Salt Range :—

*Productus Purdoni*, Dav.
„ *cf. serialis*, Waag.
*Spirifer musakheylensis*, Dav.
*Martinia glabra*, Mart. sp.
*Spirigerella Derbyi*, Waag.
*Athyris Roysii*, Lev. sp.

It is not to be wondered at that the affinities of the present fauna to that of the Productus limestone are more distinctly marked than to the faunas of non-Indian deposits, as the Salt Range is the country least distant from the Himálayas, where marine equivalents of the permian system are known to exist.

Out of these six species, identical with Productus limestone fossils, one is restricted to the lower Productus limestone and one to the upper Productus limestone only.[1] But the latter is only marked as *cf.* in my preceding list. Two species extend throughout the entire thickness of the Productus limestone formation; one occurs in the middle and upper Productus limestone and one in the upper division of the middle Productus limestone (Virgal and Kalabagh beds) only. Thus the faunistic relations to the upper division of the Productus limestone formation appear to be somewhat closer, but the difference in the number of identical species is too small to be of any importance for the stratigraphical correlation of the respective beds.

With the permocarboniferous fauna of the Ural and of the Timan region the Productus shales have only three species in common, among which one is among the leading forms of the Himálayan rock group here under consideration. These species are the following :—

*Productus cancriniformis*, Tschern.
„ *cf. cancrini*, Vern.
„ *Purdoni*, Dav.

The affinities between the faunas of the Himálayan Productus shales and the permocarboniferous deposits of Russia appear however to be much closer, if we take into consideration such species as are so very nearly allied, that advocates of a wider definition of the species might even consider them as identical. Such analogous species are the following:—

---

[1] In the grouping of the Productus beds of the Salt Range I am following Waagen's classical memoir, not the classification adopted by R. D. Oldham in the second edition of the Manual of the Geology of India (Calcutta, 893, Chapter VI).

| Russia. | Central Himálayas. |
|---|---|
| *Aviculopecten Kokscharofi*, Vern. | *A. hiemalis*, Salt. |
| *Chonetes uralica*, Moeller. | *Ch. Vishnu*, Salt. |
| *Spirifer Marcoui*, Waag. | *Sp. Ravana*, Dien. |
| ,, *fasciger*, Keyserl. | ,, *musakhelensis*, Dav. |
|  | ,, *aff. fascigero*. |
| *Athyris Roysii* (Lev.), Tschern. | *A. Roysii* (Lev.), Dien. |

From this it appears very clearly, that the relations of the fauna of the Himálayan Productus shales to that of the permocarboniferous deposits of Russia are scarcely less intimate, than to that of the upper Productus limestone of the Salt Range.

Well marked affinities are also exhibited between the fauna under consideration and that of the permocarboniferous (? and permian) rocks of Spitzbergen.

The faunistic relations between the Productus shales of Gurhwal and Kumaon and the rock groups of upper palæozic age in other countries will be shown in the tabular statement on the following page, which only contains such species as are identical (*i*) or *very* nearly allied (*a*). If we pass in review this list of species, which are identical with such as occur in foreign countries outside the Himálayas, we find among them one single form only, which has not been detected hitherto in deposits younger than carboniferous. This is ***Martinia glabra***, sp., a form of rather small geological importance, as it seems to pass up in its typical shape from the Devonian into the topmost carboniferous strata. Two species, ***Spirifer musakhelensis*** and ***Athyris Roysii***, extend from upper carboniferous into permian strata; three are restricted to beds of permocarboniferous and permian age. These are:—

*Productus Purdoni*, Dav.
,, *cf. Cancrini*, Vern.
*Spirigerella Derbyi*, Waag.

One species, ***Productus cancriniformis***, is peculiar to the topmost carboniferous and permocarboniferous, and one species, ***Productus cf. serialis***, to permian strata.

If we add to these species such as are very nearly allied to forms of the Productus shales, as: ***Spirifer Marcoui***, Waag., ***Chonetes uralica***, Moell. ***Aviculopecten Kokscharofi***, Vern., we find them likewise ranging from upper carboniferous into permian strata. Thus little evidence is afforded by them as to the stratigraphical position of the Productus shales in the general sequence of the sedimentary rocks.

The majority of species, of which the present fauna consists, are brachiopoda, which do not keep a distinct stratigraphical horizon, and are consequently of but little value for a distinction of narrowly limited geological stages. Although the general character of this fauna excludes any correlation of the Productus shales with beds of carboniferous age, it is not sufficient for deciding whether they

| | SALT RANGE. | | | | EUROPEAN RUSSIA AND URAL MOUNTAINS. | | | | | | | AMERICA. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Middle Productus limestone. | | | Upper Carboniferous. | | | | | | | | |
| | Lower Productus limestone. | Katta beds. | Virgal and Kálabágh beds. | Upper Productus limestone. | Lower Division (Moscovian stage). | Upper Division (Gshel stage). | Permocarboniferous (Artinsk stage and limestone—dolomite horizon, C Pc.) | Permian. | Timor (Permian). | Spitsbergen (Permocarboniferous and ? Permian). | Carnian Alps (Fusulina limestone). | Coalmeasures and Permocarboniferous of North America. | Coalmeasures of Itaituba (Brazil). |
| Aviculopecten hiemalis . . | ... | ... | ... | ... | ... | a | a | a | ... | a | ... | ... | ... |
| Chonetes Vishnu . . . | ... | ... | ... | ... | ... | a | a | ... | ... | a | ... | a | ... |
| „ lissarensis . . | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| Productus Purdoni . . | ... | ... | i | i | ... | ... | i | ... | ... | a | ... | ... | ... |
| „ gangeticus . . | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| „ cf. serialis . . | ... | ... | ... | i(?) | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| „ cf. Cancrini . . | ... | ... | a | a | ... | ... | i | i | ... | i | ... | i(?) | ... |
| „ cancriniformis . | ... | ... | ... | ... | ... | ... | i | ... | ... | ... | i | ... | ... |
| Spirifer Ravana . . . | a | a | ... | ... | ... | ... | a | ... | ... | a | ... | a | ... |
| „ musakhelensis . | i | i | i | i | ... | a | a | ... | i | a | i | a | a |
| „ aff. fascigero . . | a | a | a | a | ... | ... | a | ... | ... | ... | ... | ... | ... |
| „ nitiensis . . . | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| „ joharensis . . | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| Martinia glabra sp. . . | i | ... | ... | ... | i | i | ... | ... | ... | ... | i | ... | ... |
| Spirigerella Derbyi . . | ... | ... | i | i | ... | ... | ... | ... | ... | ... | ... | ... | i |
| Athyris Roysii sp. . . | i | i | i | i | ... | a | a | a | i | ... | ... | a | ... |
| Number of identical and [in parentheses] very nearly allied species. | 3[2] | 2[2] | 4[2] | 5[2] | 1 | 1[4] | 3[6] | 1[2] | 2 | 1[5] | 3 | 1[4] | 1[1] |

ought to be placed on a level with permocarboniferous or with true permian strata.

The distinctly marked affinities between the faunæ of the Productus shales and of the Artinskian stage might justify a correlation with the permocarboniferous series.[1] On the other hand it must be borne in mind that the greater part of the fauna of the Productus shales is made up by new species. Considering the intimate relationship, by which the different subdivisions of the Productus limestone formation in the Salt Range are linked together, a greater stress must be laid on the fact, that forms, very nearly allied to but not identical with Artinskian species play an important part in the present fauna. We may even ask, if it is not exactly these *new* species which ought to be considered as the feature peculiar to beds of true permian age within the sedimentary belt of the central Himálayas.

Another instance which appears to be in favour of the latter view, is the following.

North of the main region of the palæozoic belt of the Central Himálayas crags of triassic and permian rocks are found in the range of Chitichun No. 1 in Hurdés amidst the Tibetan zone of Spiti shales and Gieumal sandstones. Among these crags the main mass of the peak Chitichun No. I (17,740 feet) has furnished us with a rich fauna, consisting chiefly of brachiopods, bryozoa and corals. A large majority of the species composing this fauna (more than 60 °/₀) are identical with such as have been described by Waagen from the Virgal and Kálabágh beds in the Salt Range.[2] This fauna must therefore be placed most probably on a level with the upper division of the middle Productus limestone.

If we compare the faunas of the palæozoic limestone crag of Chitichun No. 1 and of the Himálayan Productus shales, we find them to differ rather considerably from each other. Not only is the number of identical species insignificant, but the absence of all the *Producti*, peculiar to the Chitichun fauna in the Productus shales is still more remarkable. Among these *Producti* true permian forms, like *P. Abichi* are rare, whereas such as have their chief development in carboniferous deposits, like *P. gratiosus*, *P. semireticulatus*, *P. lineatus*, *P. Cora*, are rather frequent. The presence of these forms gives a slightly more ancient aspect to the Chitichun fauna. As the latter has been proved to be homotaxial with the upper division of the middle Productus limestone, the Productus shales of the Himálayas can scarcely be considered to stand on a lower level than the upper Productus limestone of the Salt Range.

Starting from these considerations it appears more plausible, that the fauna of the Productus shales should fall homotaxically within the scope of the permian not of the permocarboniferous stages of other countries.

The only decisive evidence for a permian age of the Productus shales is however based on their stratigraphical relations to the triassic beds of the mesozoic belt of the Central Himálayas, not on their fossil remains. One of the chief results of

---

[1] In this memoir the term "Permocarboniferous" is used in the sense of the Russian geologists, not in the wider sense attributed to it either by A. de Lapparent, or by a large number of American authors.

[2] The third part of the present volume of the Himálayan Fossils is devoted to a monograph of this interesting fauna.

Griesbach's geological survey of the Bhot Mahals of Kumaon and Gurhwal is the proof of an unconformity, existing at the base of the Productus shales, which locally overlap successive strata of carboniferous age. With this unconformity another uninterrupted sequence begins, with conformable bedding throughout, which ranges from the Productus shales to the topmost beds of the triassic system. So intimate is the stratigraphical connection between the Productus shales and the following Otoceras beds of lowest triassic age, that a sharp boundary cannot be drawn between them. During his first visit to the Niti area Griesbach actually failed to distinguish the two horizons, which in the sections of Kiunglung and of the Shalshal cliff pass quite gradually into each other, and can only be conveniently separated by the rich mesozoic fauna, contained in the main layer of *Otoceras Woodwardi*. I therefore fully approve of the conclusion arrived at by Griesbach, who looks on the Productus shales as the representatives of the permian of south eastern Europe on the ground of their stratigraphical connection with the triassic and of their unconformity to the carboniferous series.

The only distinctly marked unconformity, which has been made known hitherto within the sedimentary belt of the Bhot Mahals of Gurhwal and Kumaon. is younger than the white quartzite of upper carboniferous age, which must have been partially eroded, before the overlapping Productus shales were deposited. This unconformity, though bearing evidence of considerable physical changes, does not appear to have been accompanied by intense structural displacements, which might be compared to the "Variscian" disturbances in Central Europe during the carboniferous period. The break between the upper carboniferous quartzite and the permian Productus shales probably corresponds to the permocarboniferous stage in Russia. It is not impossible, that in Central Asia this unconformity is represented by the "Tibetan transgression," the importance of which has been recently elucidated by Suess[1] on the basis of Bogdanowitsch's geological reconnaissance in the Kwen-Lun mountains.[2]

Thus Griesbach's correlation of the Productus shales with the true Permian of south-eastern Europe stands firm so far, as it is based on stratigraphical evidence. This stratigraphical evidence is, to say the least, not contradicted but rather supported by the palæontological results, as put forward in this memoir. With regard to the latter I may sum up my views in the sentence, that the fauna of the Productus shales of Kumaon and Gurhwal, as represented in Griesbach's Himálayan collections —provided it really belonged to the same stratigraphical system—should be considered of permian rather than of permocarboniferous age, although the palæontological evidence alone does not appear sufficient to decide this question.

---

[1] *E. Suess*,—Beiträge Zur Stratigraphie Central-Asiens, Denkschr. Kais. Akad. d. Wiss. Wien, math. nat. Cl. LXI, 1894, p. 435.

[2] Report on the Tibetan Expedition, 1889-90, under the command of *M. W. Pěwzow*, Pt. ii. Geological Exploration of Eastern Turkestan by *K. Bogdanowitsch* (in Russian language), St. Petersburgh, 1892, p. 61.

## EXPLANATION OF PLATES.

# PLATE I.

Figs. 1—3. Productus gangeticus, Diener. Three specimens from Kiunglung encamping ground. 1*a*, ventral view, 1*b*, lateral view, 1*c*, frontal view, 1*d*, apical view, 2, ventral valve, with partially preserved shell, 3, dorsal valve.

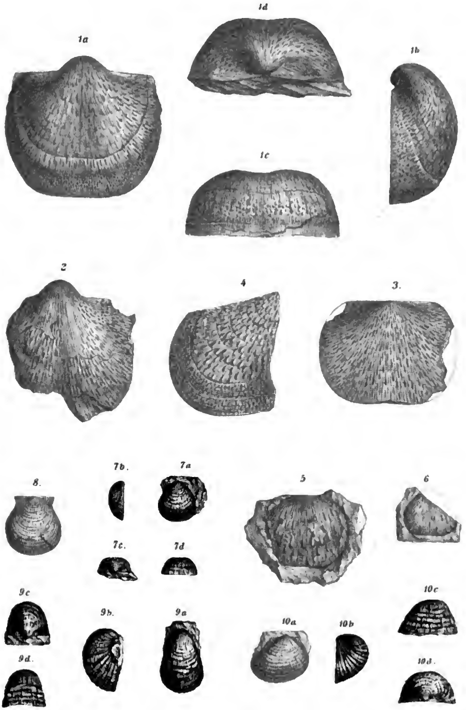
Fig. 4. Productus cf. serialis, Waagen. Cast of a dorsal valve from Kiunglung encamping ground.

Figs. 5, 6. Productus cf. Cancrini, Verneuil. Two ventral valves from Kiunglung encamping ground.

Fig. 7. Productus cancriniformis, Tschernyschew. Specimen from the permian (?) limestone with *P. tibeticus*, *Streptorhynchus difficilis*, etc., near the Gussass River (Western Kuen-Lun Mountains), collected by K. Bogdanowitsch. 7*a*, ventral view, 7*b*, lateral view, 7*c*, apical view, 7*d*, frontal view.

Figs. 8—10. Productus cancriniformis, Tschernyschew. Three specimens, from Kiunglung encamping ground, 8 dorsal valve, 9, 10 ventral valves, 9*a*, ventral view, 9*b*, lateral view, 9*c*, apical view, 9*d*, frontal view, 10*a*, ventral view, 10*b*, lateral view, 10*c*, frontal view, 10*d*, apical view.

# PRODUCTUS SHALES-FOSSILS (HIMALAYA)



A. Swoboda del. et lith.

Th. Bannwarth print.

## PLATE II.

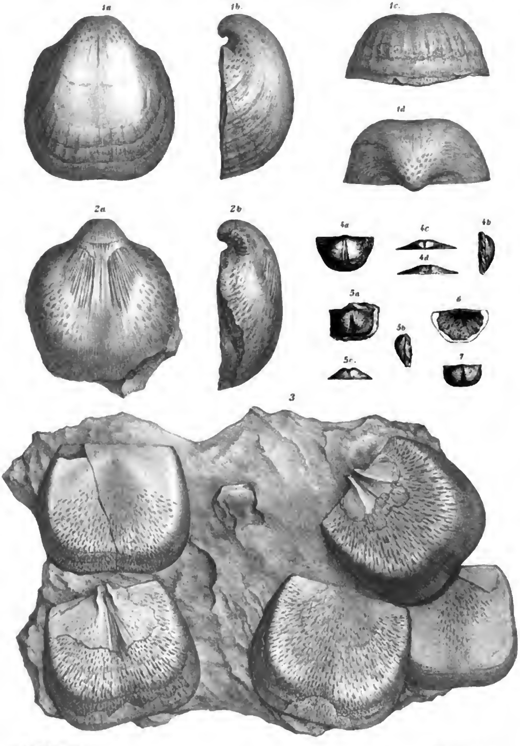
Figs. 1—2. Productus Purdoni, Davidson. Two ventral valves from Kiunglung encamping ground. 1*a*, ventral view, 1*b*, lateral view, 1*c*, frontal view, 1*d*, apical view, 2*a*, ventral view, showing part of the muscular impressions, 2*b*, lateral view, with some shell remains below the apex.

Fig. 3. Productus gangeticus, Diener. Casts of dorsal valves, with partially preserved internal structure, from Kiunglung encamping ground.

Figs. 4, 6. Chonetes lissarensis, Diener. Two specimens from S. of Dharma XI, Lissar Valley. 4, cast of ventral valve. 4*a*, ventral view, 4*b*, lateral view, 4*c*, apical view, 4*d*, frontal view, 6, dorsal valve.

Figs. 5, 7. Chonetes Vishnu, Salter. Two ventral valves from Kiunglung encamping ground. 5*a*, ventral view, 5*b*, lateral view, 5*c*, frontal view.

## PRODUCTUS SHALES-FOSSILS (HIMALAYA)



A. Swoboda del. et lith.

Th. Bannwarth print.

OF
ICH.

## PLATE III.

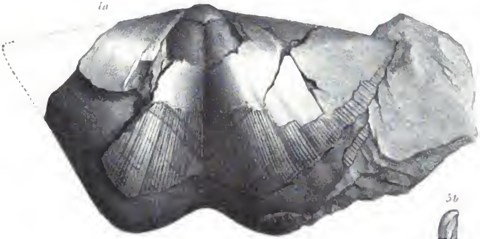
Figs. 1, 2. SPIRIFER RAVANA, Diener. 1, ventral valve from Kiunglung encamping ground. 1*a*, ventral view, 1*b*, dorsal view, 1*c*, transverse section, combined with frontal view of the median sinus, 2, fragment of a ventral valve from S. of Dharma XI, Lissar Valley.

Figs. 3, 4. SPIRIFER MUSAKHEYLENSIS, Davidson. Two specimens from Kiunglung encamping ground.

Fig 5. DIELASMA SP. IND. Fragment of a ventral valve from Kiunglung encamping ground. 5*a*, ventral view, 5*b*, lateral view.

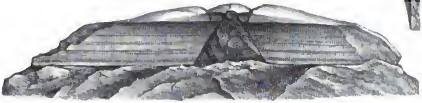
## PRODUCTUS SHALES-FOSSILS (HIMALAYA)

1a

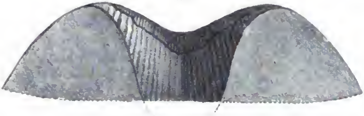


5b

1b.

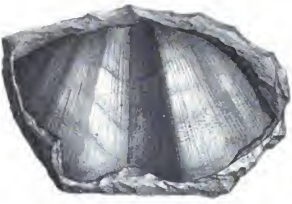


1c



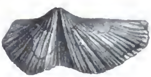
5a.

2.



3.

4



A. Swoboda del. et lith.

Th. Bannwarth print.

UNIV OF MICH.

## PLATE IV.

Figs. 1, 2. Spirifer musakheylensis, Davidson. Two specimens from Kiunglung encamping ground. 1*a*, ventral view, 1*b*, dorsal view, 2, typical form.

Fig. 3 Spirifer joharensis, Diener. Specimen from S. of Dharma XI, Lissar Valley. 3*a*, ventral view, 3*b*, dorsal view, 3*c*, lateral view.

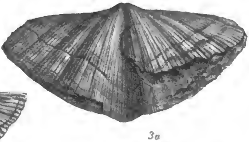
Figs. 4, 5. Spirifer nitiensis, Diener. Two specimens from Kiunglung encamping ground. 5*a*, ventral view, 5*b*, dorsal view, 5*c*, frontal view, 5*d*, apical view, 5*e*, lateral view.

Fig. 6. Spirifer sp. ind. Fragment of a ventral valve from Kiunglung encamping ground.

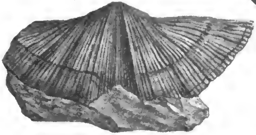
## PRODUCTUS SHALES-FOSSILS (HIMALAYA)

1b

2.



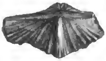
1a



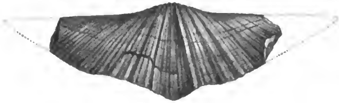
3a

4

3b.



5a.



3c

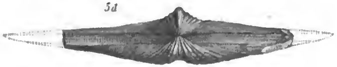
5b

5e.

5c

6.

5d



A. Swoboda del. et lith.

Th. Bannwarth print.

UNIV. OF MICH.

## PLATE V.

Fig. 1. Spirifer musakheylensis, Davidson. Largest specimen known to me, from Kiunglung encamping ground.

Figs. 2, 3. Spirifer sp. aff. fascigero, Keyserling. Two incomplete dorsal valves from Kiunglung encamping ground.

Fig. 4. Martinia glabra, Mart. sp. Complete specimen from Kiunglung encamping ground. 4*a*, dorsal view, 4*b*, ventral view, 4*c* frontal view, 4*d*, lateral view.

Figs. 5, 7. Athyris Roysii Lev. sp. Two specimens from Kiunglung encamping ground. 5, largest specimen known to me, 5*a*, ventral view, 5*b*, lateral view, 7, average sized specimen, 7*a*, dorsal view, 7*b*, ventral view, 7*c*, frontal view, 7*d*, lateral view.

Figs. 6, 8. Spirigerella Derbyi, Waagen. Two specimens from Kiunglung encamping ground. 6*a*, 8*a*, dorsal view, 6*b*, 8*b*, ventral view, 6*c*, frontal view, 6*d*, lateral view, 8*c*, lateral view, 8*d*, frontal view, 8*e*, apical view.

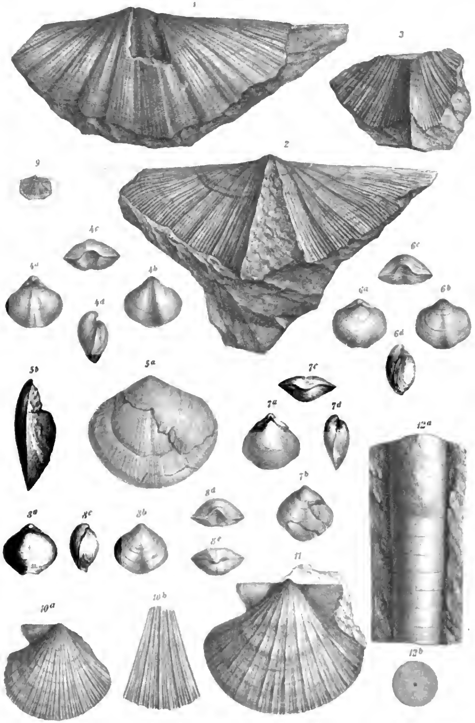
Fig. 9. Chonetes Vishnu, Salter. Fragment of a dorsal valve from Kiunglung encamping ground.

Figs. 10*a*, *b*, 11. Aviculopecten hiemalis, Salter. Two left valves from Kiunglung encamping ground.

Fig. 12. Orthoceras sp. ind. Fragment with partially preserved body chamber from the Mankshang Pass (Kuti-Yangti Valley).

The circular shape of the transverse section and the central position of the siphuncle, as represented in 12*b*, are open to grave doubts.

# PRODUCTUS SHALES-FOSSILS (HIMALAYA)



A. Swoboda del. et lith.
Th. Bannwarth print.

UNIV. OF MICH.

JAN 25 19

QE
756
.I4
A4

# MEMOIRS

OF

# THE GEOLOGICAL SURVEY OF INDIA.

India. Geological survey

# Palæontologia Indica,

BEING

FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

PUBLISHED BY ORDER OF THE GOVERNMENT OF INDIA.

## Ser. XV.

## HIMALAYAN FOSSILS,

## Vol. I, Part 5.

# PERMIAN FOSSILS OF THE CENTRAL HIMALAYAS.

PLATES I TO X.

By
**CARL DIENER, Ph. D.**
*Professor of Geology in the University of Vienna.*

CALCUTTA:
SOLD AT THE OFFICE OF THE GEOLOGICAL SURVEY, 27, CHOWRINGHEE ROAD.
LONDON: MESSRS. KEGAN PAUL, TRENCH, TRÜBNER & CO.
BERLIN: MESSRS. FRIEDLÄNDER UND SOHN.

1903.

PRINTED BY THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA, 8, HASTINGS STREET, CALCUTTA.

Price Rs. 2-8 or 3s. 6d.

# MEMOIRS OF THE GEOLOGICAL SURVEY OF INDIA.

Vol. I. Royal 8vo, pp. 309, 1859 (*out of print*). Pt. 1, 1856 (*price* 1 Re.): Preliminary notice on the Coal and Iron of Talchir.—On the geological structure and relations of the Talchir Coal-field.—Gold-yielding deposits of Upper Assam.—On specimens of gold and gold dust from Shué-gween. Pt. 2, 1858 (*price* 2 Rs.): On the geological structure of a portion of the Khasi Hills.—On the geological structure of the Nilghiri Hills (Madras). Pt. 3, 1859 (*price* 2 Rs.): On the geological structure and physical features of the Districts of Bankura, Midnapore, and Orissa.—On the laterite of Orissa.—On some fossil fish-teeth of the genus Ceratodus, from Maledi, south of Nagpur.

Vol. II. Royal 8vo, pp. 341, 1859 (*out of print*). Pt. 1, 1860 (*price* 2 Rs.): On the Vindhyan Rocks, and their associates in Bundelkand. Pt. 2, 1860 (*price* 3 Rs.): On the geological structure of the central portion of the Nerbudda District.—On the tertiary and alluvial deposits of the central portion of the Nerbudda Valley.—On the geological relations and probable geological age of the several systems of rocks in Central India and Bengal.

Vol. III. Royal 8vo, pp. 438. Pt. 1, 1863 (*price* 3 Rs.) (*out of print*): On the geological structure and relations of the Raniganj Coal-field.—Additional Remarks on the geological relations and probable geological age of the several systems of rocks in Central India and Bengal.—Indian Mineral Statistics, I, Coal. Pt. 2, 1864 (*price* 2 Rs.): On the Sub-Himálayan Ranges between the Ganges and Ravi.

Vol. IV. Royal 8vo, pp. 450. Pt. 1, 1863 (*price* 2 Rs.): Report on the Cretaceous Rocks of Trichinopoly District, Madras. Pt. 2, 1864 (*price* 2 Rs.) (*out of print*): On the structure of the Districts of Trichinopoly, Salem, etc. Pt. 3, 1865 (*price* 1 Re.): On the Coal of Assam, etc.

Vol. V. Royal 8vo, pp. 354. Pt. 1, 1865 (*price* 3 Rs.) (*out of print*): Sections across N.-W. Himálaya, from Sutlej to Indus.—On the Gypsum of Spiti. Pt. 2, 1866 (*price* 1 Re.): On the Geology of Bombay. Pt. 3, 1866 (*price* 1 Re.) (*out of print*): On the Jheria Coal-field.—Geological Observations on Western Tibet.

Vol. VI. Royal 8vo, pp. 395. Pt. 1, 1867 (*price* 8 As.): On the Neighbourhood of Lynyan, etc., in Sind.—Geology of a Portion of Cutch. Pt. 2, 1867 (*price* 2 Rs.) (*out of print*): Bokáro Coal-field.—Rámgarh Coal-field.—Traps of Western and Central India. Pt. 3, 1869 (*price* 2 Rs. 8 As.): Tapti and Nerbudda Valleys.—Frog-beds in Bombay.—*Oxyglossus pusillus.*

Vol. VII. Royal 8vo, pp. 342. Pt. 1, 1869 (*price* 3 Rs.): Vindhyan Series.—Mineral Statistics.—Coal.—Shillong Plateau. Pt. 2, 1870 (*price* 1 Re.): Karharbári Coal-field.—Deoghar Coal-field. Pt. 3, 1871 (*price* 1 Re.): Aden Water-supply.—Káraopura Coal-fields.

Vol. VIII. Royal 8vo, pp. 353. Pt. 1, 1872 (*price* 4 Rs.): On the Kadapah and Karnul Formations in the Madras Presidency. Pt. 2, 1872 (*price* 1 Re.): Itkhuri Coal-field.—Daltonganj Coal-field.—Chope Coal-field.

Vol. IX. Royal 8vo, pp. iv, 358. Pt. 1, 1872 (*price* 4 Rs.): Geology of Cutch. Pt. 2, 1872 (*price* 1 Re.): Geology of Nagpúr.—Geology of Sirban Hill.—Carboniferous Ammonites, pp. 65.

Vol. X. Royal 8vo, pp. 359. Pt. 1 (*price* 3 Rs.): Geology of Madras.—Sátpura Coal-basin. Pt. 2, 1874 (*price* 2 Rs.): Geology of Pegu.

Vol. XI. Royal 8vo, pp. 338. Pt. 1, 1874 (*price* 2 Rs.): Geology of Dárjiling and Western Duars. Pt. 2, 1876 (*price* 3 Rs.): Salt-region of Kohát, Trans-Indus.

Vol. XII. Royal 8vo, pp. 363. Pt. 1, 1877 (*price* 3 Rs.): South Mahrátta Country. Pt. 2, 1876 (*price* 2 Rs.): Coal-fields of the Nága Hills.

Vol. XIII. Royal 8vo, pp. 248. Pt. 1, 1877 (*price* 2 Rs. 8 As.): Wardha Valley Coal-field. Pt. 2, 1877 (*price* 2 Rs. 8 As.) Geology of the Rájmahál Hills.

Vol. XIV. Royal 8vo, pp. 313, 1878. Geology of the Salt Range in the Punjab.

Vol. XV. Royal 8vo, pp. 192. Pt. 1, 1878 (*price* 2 Rs. 8 As.): Geology of the Aurunga and Hutár Coal-fields (Palamow). Pt. 2, 1880 (*price* 2 Rs. 8 As.): Ramkola and Tatapani Coal-fields (Sirguja).

Vol. XVI. Royal 8vo, pp. 264. Pt. 1, 1879 (*price* 1 Re. 8 As.): Geology of Eastern Coast from Lat. 15° to Masulipatam. Pt. 2, 1880 (*price* 1 Re. 8 As.): The Nellore Portion of the Carnatic. Pt. 3, 1880 (*price* 2 Rs.): Coastal region of the Godávari District.

Vol. XVII. Royal 8vo, pp. 305. Pt. 1, 1879 (*price* 3 Rs.): Geology of Western Sind. Pt. 2, 1880 (*price* 2 Rs.): Trans-Indus extension of the Punjab Salt Range.

Vol. XVIII. Royal 8vo, pp. 300. Pt. 1, 1881 (*price* 2 Rs.): Southern Afghanistan. Pt. 2, 1881 (*price* 1 Re. 8 As.) (*out of print*): Mánbhum and Singhbhum. Pt. 3, 1881 (*price* 2 Rs.): Pránhita-Godávari Valley.

Vol. XIX. Royal 8vo, pp. 242. Pt. 1, 1882 (*price* 2 Rs.): The Cachar Earthquake of 1869. Pt. 2, 1882 (*price* 1 Re.): Thermal springs of India. Pt. 3, 1883 (*price* 1 Re.): A catalogue of Indian Earthquakes. Pt. 4, 1883 (*price* 1 Re.): Geology of parts of Manipur and the Nága Hills.

Vol. XX. Royal 8vo, pp. 240. Pt. 1, 1883 (*price* 2 Rs. 8 As.): Geology of Madura and Tinnevelly. Pt. 2, 1883 (*price* 2 Rs. 8 As.): Geological notes on the hills in the neighbourhood of the Sind and Punjab Frontier between Quetta and Dera Ghazi Khan.

Vol. XXI. Royal 8vo, pp. 286 (*out of print*). Pt. 1, 1884 (*price* 2 Rs.): Geology of the Lower Nerbudda Valley. Pt. 2, 1884 (*price* 1 Re.): Geology of Kathiawar. Pt. 3, 1885 (*price* 2 Rs.): Coal-field of South Rewah. Pt. 4, 1885 (*price* 1 Re.): Barren Island.

Vol. XXII. Royal 8vo, pp. 344, 1883. The Geology of Kashmir, Chamba, and Khagan.

Vol. XXIII. Royal 8vo, pp. 232, 1891. Geology of the Central Himálayas.

Vol. XXIV. Royal 8vo, Pt. 1, 1887 (*price* 1 Re. 8 As.): The Southern Coal-fields of the Sátpura Gondwána Basin. Pt. 2, 1890 (*price* 2 Rs. 4 As.): Physical Geology of the Sub-Himáleya of Garhwál and Kumaun. Pt. 3, 1890 (*price* 1 Re. 4 As.): Geology of South Malabar, between the Beypore and Ponnáni Rivers.

Vol. XXV. Royal 8vo, 1896: Geology of the Bellary District, Madras Presidency.

Vol. XXVI. Royal 8vo, 1896: Geology of Hazara.

Vol. XXVII. Royal 8vo. Pt. 1, 1895 (*price* 1 Re.): Marine Fossils from the Miocene of Upper Burma. Pt. 2, 1897 (*price* 4 Rs.): Occurrence of Petroleum in Burma, and its technical exploitation.

Vol. XXVIII. Royal 8vo, Pt. 1, 1898 (*price* 2 Rs.): Notes on the Geological Structure of the Chitichun region.—A note on the Allah-bund in the north-west of the Rann of Kuchh.—Geology of parts of the Myingyan, Magwe, and Pakokku Districts, Burma.—The Geology of the Mikir Hills in Assam.—On the Geology of Tirah and the Bazár Valley. Pt. 2, 1900 (*price* 3 Rs.): The Charnockite Series, a group of Archæan Hypersthenic Rocks in Peninsular India.

Vol. XXIX. Royal 8vo, 1900 (*price* 5 Rs.): Report on the Great Earthquake of 12th June 1897.

Vol. XXX. Royal 8vo, Pt. 1, 1900 (*price* 2 Rs.): After-shocks of the Great Earthquake of 12th June 1897. Pt. 2, 1900 (*price* 1 Re.): Geology of the neighbourhood of Salem, Madras Presidency, with special reference to Leschenault de la Tour's observations. Pt. 3, 1901 (*price* 1 Re.): Sivamalai Series of Elæolite-Syenites. Pt. 4, 1901 (*price* 1 Re.): Report of the Geological Congress of Paris.

Vol. XXXI. Royal 8vo. Pt. 1, 1901 (*price* 2 Rs.): Geology of the Son Valley in the Rewah State and of parts of the Adjoining Districts of Jabalpur and Mirzapur. Pt. 2, 1901 (*price* 3 Rs.): A Geological sketch of the Baluchistan Desert and part of Eastern Persia. Pt. 3, 1901 (*price* 1 Re.): Petrological notes on some Peridotites, Serpentines, etc., from Ladakh.

Vol. XXXII. Royal 8vo. Pt. 1, 1901 (*price* 1 Re.): Recent Artesian Experiments in India. Pt. 2, 1901 (*price* 2 Rs.): Report on the Rampur Coal field. Pt. 3, 1902 (*price* 3 Rs.): Notes on the "Exotic Blocks" of Malla Johar in the Bhot Mahals of Kumaon.

Vol. XXXIII. Royal 8vo. Pt. 1, 1901 (*price* 8 Rs.): The Kolar Gold field, being a description of Quartz-Mining and Gold-Recovery as practised in India. Pt. 2, 1901 (*price* 2 Rs.): The Gold-fields of Wainád.—Report on the Auriferous Quartzites of Parbadiah, Chota Nagpur.—Some Auriferous localities in North Coimbatore. Pt. 3, 1902 (*price* 1 Re.): The Geology of the Kalahandi State, Central Provinces.

Vol. XXXIV. Royal 8vo. Pt. 1, 1901 (*price* 1 Re.): On a peculiar form of altered Peridotite in Mysore State. Pt. 2, 1902 (*price* 3 Rs.): The Mica deposits of India. Pt. 3, 1903 (*price* 1 Re.): A Note on the Sandhills of Clifton near Karachi.

Vol. XXXV. Royal 8vo. Pt. 1, 1902 (*price* 2 Rs.): Geology of Western Rajputana. Pt. 2, 1903 (*price* 1 Re.): After-shocks of the Great Earthquake of 12th June 1897. Pt. 3 (*in the Press*): The seismic phenomena in British India and their connection with its Geology.

Vol. XXXVI. Royal 8vo. Pt. 1 (*in the Press*): Geology of Spiti.

# Palæontologia Indica.

SERIES XV.

VOL. I, PART 5.

CALCUTTA:
GOVERNMENT OF INDIA CENTRAL PRINTING OFFICE,
8, HASTINGS STREET.

HIMALAYAN FOSSILS.

VOLUME I, PART 5.

# PERMIAN FOSSILS OF THE CENTRAL HIMALAYAS.

(COLLECTIONS MADE BY THE GEOLOGICAL SURVEY OF INDIA DURING THE YEARS 1898—1900.)

BY

CARL DIENER, PH.D.,
*Professor of Geology at the University of Vienna.*

## INTRODUCTION.

In Parts 2, 3 and 4 of the present volume a special description has been published of all fossils of the anthracolithic series which had been found in the Himalayas until the year 1893 and were included in the collections of the Geological Survey of India. The important results which the palæontological examination of the large Himalayan collections had yielded induced Mr. C. L. Griesbach, Director of the Geological Survey of India, to make his officers resume survey work in the Himalayas during the hot season of 1898. Thus in 1898 Mr. H. H. Hayden was despatched to Spiti, where he made detailed studies in the region of the upper Pin valley and adjoining areas and obtained fine collections of fossils from almost all the beds between the cambrian and the upper trias. Survey work was continued in Spiti during the following summer by Mr. H. H. Hayden and Dr. A. von Krafft, who mapped a large portion of that district and made very rich collections from several fossiliferous horizons. In the same season Mr. T. D. La Touche was deputed to the upper Lissar Valley in Kumaon, Mr. F. H. Smith to Byans and the Kuti Yangti Valley, and Dr. T. L. Walker to the permian crags or "klippen" of Chitichun. In 1900 Dr. A. von Krafft made an exhaustive study of the crags in the neighbourhood of the Balchdhura. During all these expeditions large collections of fossils were made. Part of these collections, comprising the fossils of the anthracolithic series, were submitted to me for examination. The results of the investigation of this valuable material are described in the following pages.

The overwhelming majority of fossils from the anthracolithic rocks of the Central Himalayas, which have been collected by the above-named officers of the Geological Survey of India during the years 1898 to 1900 and submitted to me for examination, are of permian age. The description of this permian fauna completes the three foregoing parts of the present volume, and it may safely be said that the species described in the following chapters are of special interest, and allow certain general conclusions to be drawn.

In accordance with a wish expressed by Mr. C. L. Griesbach, the descriptions of the species have been disposed according to localities and horizons, and the plates have been so arranged that illustrations of fossils from the same group of rocks are included in one plate. By such a mode of procedure an important advantage has been obtained from the possibility of avoiding confusion and of tracing with more certainty the palæontological characters of every well established horizon with a distinct fauna. In comparison with this great advantage, the unfortunate necessity of occasional repetitions previously given of species in the parts already printed is of secondary importance. Thus, I hope, the treatment of fossils according to their stratigraphical horizon and to the geographical district in which they have been collected, will not be felt inconvenient.

Since the publication of my first studies of the permian fossils of the Himalayas (part 4 of the present volume) several important works have been published which throw new light on some very interesting faunæ of the anthracolithic system. Of Gemmellaro's memoir on the permian fauna of the Fusulina limestone of Sosio in Sicily, the first part of the description of the Brachiopoda appeared in 1899. A revision of the fauna of the permian Otoceras beds of Djulfa in Armenia was made by G. von Arthaber in 1900 (Beiträge zur Geol. und Palæontologie Oesterr.-Ungarns, etc., Bd. XII). In the 13th volume of the same "Beiträge" Dr. Enderle described an interesting fauna of anthracolithic age from Balia Maaden in Asia Minor. The upper carboniferous fossils from Sumatra and Loping, which had been described by Römer and Kayser, were revised by Fliegel (Palæontographica, Bd. 48). Valuable contributions to our knowledge of the permian fauna of Eastern Russia have been added by Netschajew. A very rich and remarkable fauna of permocarboniferous age has been discovered in the south-eastern Alps of Carinthia and Carniola by Geyer and Schellwien and excellently illustrated by the latter author in the 16th volume of the Abhandlungen der K. K. Geol. Reichs-Anstalt.

A most important work, dealing with several of the most general palæontological questions concerning the classification of Brachiopoda, to which I had no opportunity to refer in my previous publications, is the "Introduction to the study of the genera of fossil Brachiopoda" by Hall and Clarke. (Palæontology of New York, volume VIII.)

Besides the palæontological literature, the list of which has been given in Part 2 of the present volume (pp. 10—13), the above are the recent publications, which I chiefly consulted when working out the present memoir.

I am greatly indebted to my distinguished friend Prof. Th. Tschernyscheff of St. Petersburgh, who kindly furnished me with the plates accompanying his monograph of the carboniferous Brachiopoda of the Ural Mountains. As this memoir is still in the press, no comparison of my Himalayan fossils with the rich upper carboniferous Brachiopod fauna of the Ural and Timan would have been possible without his kind assistance.

## I.—FOSSILS FROM THE PERMIAN LIMESTONE CRAG OF CHITICHUN No. I. (HUNDES.)

A systematic description of the fossils collected by Messrs. Griesbach, Middlemiss and the author in 1892, in the permian limestone crag of Chitichun No. I, has been published in the third part of this volume (1897). The chief stratigraphical result, to which those palæontological researches led, is that the fauna of Chitichun No. I corresponds to the fauna of the upper portion of the middle Productus limestone of the Salt Range, and, among European strata, is very probably equivalent either to the Artinskian stage of Russia or to the Permian limestone crags of Sosio in Sicily.

In 1899 Dr. T. L. Walker visited the classic locality of Chitichun No. I, whence he obtained a small but interesting suite of fossils. The majority of them were collected on loose talus-heaps, surrounding the base of the actual crag.

Of this collection the following species have been identified :—

*Crustacea.*

1. *Phillipsia Middlemissi*, Diener.

*Cephalopoda.*

2. *Nautilus hunicus*, nov. sp.
3. *Xenaspis carbonaria*, Waagen.
4. *Cyclolobus Walkeri*, nov. sp.

*Gastropoda.*

5. *Naticopsis*, sp. ind.

*Brachiopoda.*

6. *Productus semireticulatus*, Mart.
7. „ *Chitichunensis*, Diener.
8. „ *cf. subcostatus*, Waag.
9. „ *gratiosus*, Waag.
10. „ *Abichi*, Waag.
11. *Marginifera typica*, Waag.
12. *Aulosteges tibeticus*, Diener.
13. *Lyttonia*, sp. ind.

14. *Spiriferina octoplicata var. fastigata*, Schellw.
15. „ *Margaritæ*, Gemm.
16. *Spirifer Wynnei*, Waag.
17. *Spirifer tibetanus*, Diener.
18. *Martinia nucula*, Rothpl.
19. „ *acutomarginalis*, Diener.
20. „ *semiplana*, Waag.
21. *Reticularia cf. lineata*, Mart.
22. „ *pulcherrima*, Gemm.
23. „ *inæquilateralis*, Gemm.
24. *Spirigera (Athyris) Royssii*, Lév.
25. „ „ *expansa*, Phill.
26. *Hustedia grandicosta*, Dav. (=*remota*, Eichw.).
27. *Uncinella cf. indica*, Waag.
28. *Enteletes Tschernyscheffi*, Dien.
29. „ *Waageni*, Gemm.
30. „ *subæquivalvis*, Gemm.
31. *Terebratuloidea cf. depressa*, Waag.
32. *Uncinulus timorensis*, Beyr.
33. „ *jabiensis*, Waag.
34. *Camarophoria globulina*, Phill.
35. „ *Purdoni*, Dav.
36. „ *Purdoni var. gigantea*, Dien.
37. „ *cf. semiplicata*, Gemm.
38. *Hemiptychina himalayensis*, Dav.
39. „ *sparsiplicata*, Waag.
40. „ *inflata*, Waag.
41. „ *sublævis*, Waag.
42. *Dielasma elongatum*, Schloth.
43. „ *plica*, Kutorga.
44. „ sp. ind. aff. *hastæforme*, Kon.
45. *Notothyris triplicata*, Dien.
46. „ *mediterranea*, Gemm.
47. „ *exilis*, Gemm.
48. „ *Walkeri*, nov. sp.
49. *Richthofenia*, sp. ind.

### *Crinoidea.*

50. *Poteriocrinus* (?), sp. ind.

### *Anthozoa.*

51. *Amplexus coralloides var. Abichi*, Waag.
52. *Zaphrentis Beyrichi*, Rothpl.
53. *Clisiophyllum*, sp. ind.
54. *Dibunophyllum*, sp. ind.
55. *Pterophyllum*, sp. ind.

Among these 55 species are 28 which previously had not been known to occur in the permian limestone of Chitichun No. I, and 7 previously described, but of which a revised description seemed desirable.

The species are as follows:—

## CEPHALOPODA.

### NAUTILUS (DOMATOCERAS?) HUNICUS, nov. sp., Pl. I, fig. 1.

This species is represented by a single specimen only, the living chamber of which is almost entirely preserved. Neither the innermost volutions nor the shell are available for examination. An exact diagnosis is rather difficult on account of the poorly preserved condition of my specimen.

The species is subdiscoidal, provided with a large umbilicus, which nearly equals the dorso-ventral diameter of the last volution near the aperture. The number of volutions is not exactly known to me, nor can the presence or absence of an umbilical perforation be ascertained. The whorls overlap each other, but very slightly. The last volution is of quadrangular shape. Its greatest transverse diameter corresponds to the umbilical margin, but the distance between the outer angles of the last whorl is but very little smaller. The external portion is broadly flattened and slightly concave in the middle. The lateral parts are flattened and are separated from the external area and from the steeply inclined umbilical wall by broadly rounded margins.

The volution preceding the last whorl is remarkable for the more rounded shape of its transverse section and for a more considerable difference in the size of the transverse diameters between the umbilical and peripheral angles.

The two last volutions, which alone are sufficiently preserved for observation, increase rather slowly in size, enlarging their diameter less than threefold each turn.

The transverse diameter through the umbilical shoulders is a little greater than the height of the last volution.

My specimen is an internal cast, without any trace of sculpture. Fragments of the shelly substance, which have been preserved, exhibit numerous and distinct lines of growth, which are, like the septa, curved slightly backwards where they cross the siphonal area.

The following measurements have been taken from the specimen, which has a diameter of 69 mm.:—

| | |
|---|---|
| Diameter of the shell | 69 mm. |
| " " " umbilicus | 26 " |
| Height } of the last volution | 27 " |
| Thickness } of the last volution | 28 " |

Though one-half of the last volution belongs to the body-chamber, the aperture has, unfortunately, not been preserved.

*Sutures.*—A shallow ventral or siphonal lobe is followed by a small saddle corresponding to the external margin. Lateral lobe broad and moderately deep. From the umbilical margin the sutural line takes a slight backward curve towards the dorsal side of the volution. By severing the chambered portion of the last volution from the preceding whorl, I have been able to convince myself of the presence of a funnel-shaped dorsal or internal lobe and of the central position of the siphuncle.

The septa are neither numerous nor closely arranged, as in the majority of palæozoic species.

*Remarks.*—I am in some doubt with regard to the generic relations of this species. The propriety of placing it in Hyatt's genus *Solenoceras* is questionable. *Solenoceras*, according to Hyatt's diagnosis,[1] includes *Nautilidæ* of the Carboniferous, Dyas and Trias, having quadrate whorls with depressed abdomina, central siphons and a smooth shell. In these characters the present species agrees pretty well with *Solenoceras*, although its whorls become tetragonal in the adult stage only. Hyatt, however, regarded *Nautilus transitorius*, Waagen, (Salt Range Foss., Pal. Ind., ser. XIII, vol. I, Prod. limestone foss., p. 53, Pl. V, fig. 1) from the Salt Range Productus limestone, as the prototype of his genus. From this species *Nautilus hunicus* differs strongly in the absence of gibbous ribs and of flat ridges, bordering the concavity in the siphonal area. I consequently do not feel justified in placing my Himalayan species in the series of Hyatt's *Rutoceratidæ*, most of which are distinguished by exceedingly rough shells.

A group of forms, to which the present one seems to be more nearly allied, has been included by Hyatt in his genus *Discitoceras* (l. c., p. 292), which is a synonym of the genus *Discites*, M'Coy.

If *Nautilus planotergatus*, M'Coy, were taken as the prototype of *Discitoceras*, I should not hesitate for a moment in placing *Nautilus hunicus* in this genus, both species agreeing in the development of slowly increasing whorls, with large umbilici and tetragonal cross-sections. The siphuncle, it is true, is situated above the centre in the mountain-limestone species of *Discitoceras*, but the variability of the position of the siphuncle is so great in the family of *Nautilidæ*, that no generic distinction can be based on it. The majority of species belonging to *Discitoceras* are, however, distinguished by the presence of strongly developed longitudinal or spiral ridges. Also Hyatt in his diagnosis of the genus explicitly remarks: "The young are ridged longitudinally, with prominent transverse striæ, but though these cross and roughen the ridges, they do not render them subspinous."

If we adhere strictly to this diagnosis, attributing to the longitudinal sculpture a value of generic importance, *Nautilus hunicus* can hardly be classed among the representatives of *Discitoceras*, being entirely devoid of any spiral ornamentation.

I have already alluded to the similarity of the present species to *Nautilus planotergatus*, M'Coy (Synopsis of the carboniferous foss. of Ireland, p. 18, Pl. II, fig. 2[2]). But this similarity is confined to the external shape of the last volution only, the inner volutions of the Irish species differing remarkably from *Nautilus hunicus* by their quadrangular outlines and their simple sutures.

---

[1] *Hyatt*: Genera of fossil Cephalopods. Proceedings of the Boston Soc. of Natural History, vol. XXII, 1883, p. 286.

[2] In the explanation of Plate II this species has been designated *Nautilus planodorsatus*, M'Coy.

For *N. planotergatus* and its allies a new genus, *Domatoceras*, has recently been proposed by Hyatt (Geol. Survey of Texas, 2nd Annual Report, 1890, p. 342). So far as I am able to judge from the short diagnosis given by Hyatt, this genus seems to differ from *Discitoceras*, chiefly by its more robust shape and by the lateral parts being nearly parallel or slightly convergent. Thus *Domatoceras*, with which, among European *Nautilidæ*, *N. mosquensis*, Tzwetaew, and of American ones *N. umbilicatus*, Hyatt, and *N. highlandensis*, Meek and Worthen, are placed by Hyatt, is the genus with which the present species ought most probably to be classed.

Among palæozoic species of *Nautilidæ* none appear to be more nearly allied to *Nautilus hunicus* than a group of forms from the permian Otoceras beds of Djulfa, which have been described by Abich and revised by G. von Arthaber. These species are: *Nautilus parallelus*, Abich (Eine Bergkalkfauna aus der Araxesenge bei Djoulfa, p. 17, Taf. III, fig. 2), *N. convergens*, Abich (l. c., p. 18, Taf. II, fig. 2), and *N. dolerus*, Abich (l. c., p. 18, Taf. X, fig. 1). These three species have, unfortunately, been based on very poorly preserved type-specimens only. The views which have been taken by different authors regarding the propriety of their specific claims consequently differ so widely from each other, that it is almost impossible to arrive at a satisfactory diagnosis of their specific characters.

It is especially the specimen, described and figured as *Nautilus parallelus* by G. v. Arthaber (Beiträge zur Palæontologie und Geologie Oesterreich-Ungarns, etc. Bd. XII, p. 213, Taf. XVIII, fig. 2), that I have been able to compare with my Himalayan species. They fully agree in nearly all their essential characters, *viz.*, in the outlines of their transverse sections, in the central position of the siphuncle, in the absence of any sculpture, and in the arrangement of the sutural line. The chief point of difference, so far as one can judge from the imperfect Armenian fragment, consists in the considerably greater distance between the septa in *Nautilus hunicus*. In this respect my Himalayan specimen differs from all other palæozoic species and strongly resembles some triassic representatives of *Nautilidæ*, such as *Nautilus quadrangulus*, Beyrich (Abhandl. Kgl. Akad. d. Wissensch., Berlin, 1866, p. 137, Taf. III, fig. 5); but *Nautilus quadrangulus* has more involute whorls which overlap one another to about one-half of their height, and is provided with a low, oblique umbilical wall.

In its general shape *Nautilus hunicus* bears a closer resemblance to *Nautilus brahmanicus*, Griesbach, from the Himalayan Otoceras beds. With the latter species it agrees in the character of the umbilical wall and siphonal area, which is slightly convex in young specimens, but becomes almost flat in more advanced stages of growth and is often provided with a shallow depression along its median line. *N. brahmanicus*, however, differs remarkably in the external position of its siphuncle and in its more strongly overlapping volutions, one-third of the penultimate whorl being covered by the dorsum of the last volution.

I consequently believe that, in spite of the greater distance between its septa, the present species ought to be classed among the series of palæozoic *Nautilidæ* of which ***Nautilus*** **(*Domatoceras*)** ***mosquensis***, Tzwetaew (Mem. Com. Géol. St. Pétersbourg, vol. V, No. 3, p. 52, Pl. VI, figs. 37, 38), may be considered as the prototype.

Waagen (Pal. Ind., ser. XIII, vol. I, p. 60) has referred ***Nautilus convergens***, Abich, to his group of "*ophionei*," but this group is readily distinguished from ***Nautilus hunicus*** by its more numerous and rounded whorls, by its larger umbilicus, and by the absence of a siphonal lobe. To me, therefore, the similarity of Waagen's group of "*ophionei*" to ***Nautilus convergens*** and its allies seems to be rather distant only.

### XENASPIS CARBONARIA, Waagen, Pl. I, fig. 2.

1872. *Ceratites carbonarius*, Waagen. Memoirs, Geol. Survey of India, vol. IX, p. 355, Pl. I, figs. 2, 3.
1879. *Xenodiscus carbonarius*, Waagen. Salt Range Fossils, Palæontologia Indica, ser. XIII. vol. I; Productus limestone foss., p. 35, Pl. II, figs. 2—5.
1895. *Xenaspis carbonaria*, Waagen., *ibid*., vol. II, Fossils from the Ceratite formation, p. 161.

In 1895, Waagen introduced the genus ***Xenaspis*** for the group of ***Ceratites carbonarius***, which he had previously included in the genus ***Xenodiscus***. In my memoir on the Cephalopoda of the lower Trias of the Himalayas I accepted the new genus as defined by Waagen. I considered it justifiable to separate ***Xenaspis*** from ***Meekoceras***, White (***Gyronites***, Waagen), ***Prionolobus***, Waagen, and ***Ophiceras***, Griesb., to which this genus bears a striking similarity in its general shape, not only on account of the different length of body-chamber, but also owing to the different course of development of the sutural line in the lower triassic genus. I consequently distinguished four genera among the permian and lower triassic representatives of ***Gymnitinæ***, namely: ***Ophiceras*** and ***Flemingites***, both comprising evolute forms with a short body-chamber and a spiral sculpture, on the one hand, and ***Xenaspis*** and ***Vishnuites***, characterized by a long body-chamber, on the other.

I prefer to maintain this view provisionally, so far at least as regards the generic difference of ***Xenaspis*** and ***Meekoceras*** (***Gyronites***, ***Prionolobus***), notwithstanding the arguments of several palæontologists, who are disinclined to consider the length of the body-chamber in ammonites as a character of importance for their generic distinction.

Against the view of such learned authors, who, like Haug, consider the importance of the length of the body-chamber in the classification of ammonites as of little value, but lay special stress on the arrangement of sutures only, the following passage from Waagen's Memoir "Die Formenreihe des ***Ammonites subradiatus***" (Geognost. Palæont. Beiträge, München, II Bd., 2 Heft) may be quoted :—

> "We can see that in the development of new mutations the general shape—being the one that changes first—is most readily affected by the tendency to transformation. After that follow the sutural line, the shape of the body-chamber and aperture,—lastly, the sculpture. It is obvious, and in accord with other experiences, that characters so easily influenced by variation must be of the least importance for the organisation of the animal, that on the other hand characters showing the strongest resistance to variation must stand in close connexion with the anatomico-morphological structure of the animal. Thus a change in such parts would involve a more or less considerable change

in the animal's principal qualities. This argument may be applied to the classification of ammonites, and there shows its importance. Hence the general shape, which in so many cases has been considered as the most important basis of classification (Eintheilungsgrund), will now appear to be of the least consequence, whereas characters that were neglected by all except Suess, namely, aperture and body-chamber, will form the strongest bases of classification."

I am glad to state that E. Philippi, in his excellent monograph of the Ceratites of the German Upper Muschelkalk (Palæontologische Abhandlungen von Dames und Koken, vol. VIII, Pt. 4), entirely agrees with me both in the classification of the *Gymnitinæ*, and in the supposition that a phylogenetic relationship exists between *Xenaspis* and *Gymnites*.

Dr. Noetling in his Beiträge zur Geologie der Salt Range (Neues Jahrb. f. Mineralogie, etc., Beilagebd. XIV, 1901, p. 460) takes a different view of the matter. He is of opinion that the length of the body-chamber cannot be considered of paramount importance, and strongly criticises Waagen for having found a generic distinction between *Xenodiscus*, *Xenaspis* and *Gyronites* absolutely necessary. "The absurdity of such distinctions," he states, "is clearly obvious, when we have to decide whether a well-preserved specimen, whose body-chamber is imperfect, should be classed with *Xenodiscus* or *Gyronites*. Whatever be our decision, no one can prove whether we are right or wrong."

Noetling's remarks are entirely justified from a geologist's point of view, and I fully agree with him in the opinion that the difficulty of arriving at a satisfactory determination of fossil ammonites is considerably increased by the method of separating genera on the basis of characters, which in fossil examples are only accidentally available for observation. I do not, however, see any way out of this difficulty. If a series of forms contains an assemblage of characters not common to other forms, it must be kept generically separate from the latter so long as palæontology is based on zoological principles. As a biological science, palæontology cannot satisfy the requirement of geologists, that the distinction of genera should rest only on such peculiarities as are accessible to observation in the majority of fossil remains. This requirement palæontology is not able to satisfy except in a few instances. The difficulty of distinguishing fossil Gastropoda is well known and is universally accepted. Their classification has been based, since the times of Cuvier and Milne Edwards, on organs which are never preserved in the fossil state. Yet no palæontologist dares to object to this method, nor to introduce one for recent, and another for fossil, shells. I must therefore insist on the value of the length of the body-chamber as a character of generic importance, although in fossil ammonites we find it very exceptionally in a state of perfect preservation.

The generic claims of *Xenodiscus* or of *Xenaspis* are therefore equal to those of *Celtites*, which has been acknowledged as a proper genus by all palæontologists, but is only distinguished from the *Ceratitidæ* by the length of its body-chamber.

In one case only should I feel considerable uncertainty as to whether *Xenodiscus* and *Xenaspis* should or should not be considered generically distinct from *Gyronites*. If a number of examples were found, which from their intermediate character left us in doubt as to which of those genera they should be referred to, the advisability of questioning the generic importance of the length of the body-chamber in ammonites might be admitted. But at present I have no reason to suppose that so great a variability in the length of the body-chamber really exists among the group of permian and lower triassic ammonites, which have been divided into the genera ***Xenodiscus***, ***Xenaspis***, ***Gyronites*** and ***Prionolobus*** by Waagen.

There is, however, a second and more delicate point, to which Dr. Noetling alludes in his above-quoted memoir, and this is the separation of ***Xenodiscus*** and ***Xenaspis*** as introduced by Waagen. To this separation Noetling strongly objects. He observes that from his own collections there remains no doubt as to a distinct ornamentation in ***Xenaspis***, which, being provided with prominent ribs, cannot be placed among the ***Ammonea leiostraca***, as has been suggested by Waagen.

If we compare Waagen's type-specimen of ***Xenaspis carbonaria*** or the triassic species, which were classed by myself among the genus ***Xenaspis***, with ***Xenodiscus plicatus***, Waagen, the prototype of the genus ***Xenodiscus sensu*** (***stricto***), the difference of their sculpture will be obvious. I must, however, candidly admit the possibility of intermediate or transitional forms being found to connect these widely differing extremes. Then, indeed, a great difficulty might be experienced in the attempt to separate ***Xenodiscus*** and ***Xenaspis***. I have pointed out the difficulty of distinguishing between ***Ammonea leiostraca*** and ***trachyostraca*** in those cases in which a strongly sculptured species, which belongs decidedly to the ***trachyostraca***, is connected with a smooth one by a series of transitional shapes, as is the case in many species of ***Danubites*** and ***Gyronites***.

These transitional series, within which the two sub-divisions must be distinguished in a rather arbitrary manner, clearly point to a closer relationship, by which they appear to be linked together. They seem to prove that the classification proposed by E. von Mojsisovics, which has been followed advantageously in the descriptions of upper triassic ammonites, becomes useless, if one has to deal with ammonites of permian or of lower triassic age.

It must be confessed that I have not been able to arrive at a satisfactory conclusion with regard to the points upon which the difference of opinion between Noetling and Waagen principally depends. The subject may still afford grounds for further discussion, but this, I think, would be advantageously delayed till a thorough revision of the fossils from the Ceratite formation has been completed. Then only will it be possible to determine how far we may be permitted to limit the extent of genera among ammonites with ceratitic sutures, which all appear connected and linked together most intimately by intermediate and insensible gradations of shape and ornamentation.

Without wishing to deny the possibility, or even the probability, of the correctness of Dr. Noetling's conclusions, I therefore considered it desirable to retain provisionally the proper generic denomination of ***Xenaspis*** for the smooth or faintly ornamented types of ***Xenodiscus***, which differ from ***Gyronites*** or ***Prionolobus*** by the presence of a long body-chamber.

In Walker's collection *Xenaspis carbonaria*, Waag., is represented by a single specimen, which is, however, sufficiently well preserved to admit of its identification being made with certainty.

My specimen is considerably smaller than the two large examples figured by Waagen, but is almost as large as the chambered fragment from Jabi, which gave Waagen an opportunity for studying the sutural line of the species. The mode of involution and the outlines of the transverse section are exactly identical in both specimens. It is chiefly by the small amount of overlap that the present shell is readily distinguished from the very similar *Ophiceras Sakuntala*, Diener. Whereas in *O. Sakuntala* the whorls overlap each other by more than one-half their height, in the present specimen little more than the siphonal area of the penultimate whorl is covered by the last volution. The siphonal area is somewhat flattened and joins the very slightly arched lateral parts in a sharply rounded ventral margin. The umbilical margin is less distinctly defined. From this margin the umbilical wall slopes to the umbilical suture at an angle of 45 degrees.

The largest transverse diameter is situated a little below the middle of the height of the cross-section, which, consequently, is oval rather than lanceolate.

The shelly layer, which has been partly preserved, is entirely smooth. Even in the distal portion of the last whorl, which corresponds to the body-chamber, the surface does not exhibit any trace of ribs or folds. In my specimens a little more than one-half of the last volution belongs to the body-chamber, but as the peristome is not preserved, the actual length of the body-chamber must have been considerably greater.

The measurements of this specimen are as follows :—

| | | |
|---|---|---|
| Diameter of the shell | | 36 mm. |
| „ „ umbilicus | | 14 „ |
| Height of the last volution | from the umbilical suture | 13 „ |
| | „ preceding whorl | 11·5 „ |
| Thickness of the last volution | | 7 „ |

*Sutures.*—The sutures are identical with those in Waagen's type-specimen from Jabi (l. c., pl. II, fig. 4 *c*). The siphonal lobe is broad and short and is divided by a median prominence, which is at an equal height with the middle of the siphonal saddle. Besides the siphonal lobe and saddle, two lateral lobes and saddles are present, but no auxiliary elements. The inner wall of the second lateral saddle is cut off by the umbilical suture before any auxiliary lobe has been developed.

All the lobes are provided with denticulations. Their denticulate character is easily destroyed by weathering or by an incautious use of muriatic acid. But, where the lobes were cleared cautiously, their termination in distinctly serrated ogival arches has been made clearly visible.

The arrangement of the sutures is a decisive argument in favour of an identification of the present specimen with *Xenaspis carbonaria*. From all the species of *Ophiceras*, some of which it very closely resembles in its general shape and outlines, it differs remarkably by the absence of any auxiliary elements. The same remark applies to the majority of species, which have been included in the genus *Gyronites* by Waagen, with the single exception of *G. nangaënsis* and *G. vermiformis*. *Gyronites nangaënsis*, Waagen (Salt Range Foss., Pal. Ind., ser. XIII, vol. II, Fossils from the ceratite formation, p. 297, Pl. XXXVII, fig. 5), however, though imitating *Xenaspis carbonaria* in the arrangement of its sutural elements, can be distinguished from the latter species at a glance by its more slowly increasing volutions and biangular outlines. With *G. vermiformis* also the external similarity of our specimen is only very distant.

In the Salt Range *Xenaspis carbonaria* is restricted, according to Noetling's observations, to the topmost beds of the middle Productus limestone.

### CYCLOLOBUS WALKERI, nov. sp., Pl. I, fig. 3.

It is well known how great an interest both geologists and palæontologists have attached to the discovery of the famous *Cyclolobus Oldhami*, collected by Waagen in the upper Productus limestone of Jabi. Waagen, in his first description of this "oldest true Ammonite" (Mem. Geol. Surv. of India, vol. IX, p. 351), attributed it to the genus *Phylloceras*. E. von Mojsisovics in 1873 (Das Gebirge um Hallstatt, Abhandlgn. K. K. Geol. Reichs., VI, Bd. I, Th., pp. 72, 83) pointed out its affinity to the triassic genus *Arcestes*,[1] especially to the groups of *Cymbiformes* and *Tornati*. "*Arcestes Oldhami*," he states, "resembles the former in the parabolic arrangement of its sutures, and the latter in the development of indentations at the base of the lobes." In his monograph on the Productus limestone fossils (Salt Range Fossils, Pal. Ind., ser. XIII, vol. I, p. 21), Waagen retracted his former identification and fully confirmed the correctness of E. von Mojsisovics' statement, but introduced the new genus *Cyclolobus* for the reception of the ammonite from Jabi.

Waagen considers the following characters of importance for the separation of the new genus *Cyclolobus* from the group of *Arcestes cymbiformis*. "In *Arcestes cymbiformis* and its allies the single lobes are much more ramified, and secondary lobes appear between the principal ones. The distance of the septa is about equal throughout their extension and not much larger on the siphonal part of the shell, as is the case in *Cyclolobus*, and the lobes of the succeeding septa are not shifted sideways."

In 1882 E. von Mojsisovics, in his memoir "Cephalopoden der Mediterranen Trias provinz" (Abhandl. K. K. Geol. Reichs., X, p. 166), described a large number of ammonites of the group of *Arcestes cymbiformis*, for which the new generic designation *Joannites* was introduced. While pointing out the close affinity of this new genus to *Cyclolobus*, he remarks that *Joannites* differs from *Cyclolobus* in its polyphyllic and bipartite saddles, this being, however, the only difference of sufficient importamce to justify a separation of the two genera.

Among Walker's collection from the permian limestone of Chitichun No. I, there is a specimen of *Cyclolobus*, which appears to be distinguished from *C. Oldhami* by the character of its sutural line, which points to a still more intimate relationship with the genus *Joannites* of triassic age.

The only individual representing this interesting species, for whose specific denomination the name of its discoverer is proposed, is an entirely chambered cast. Of the shelly layer only small fragments have been preserved. Of the body-chamber nothing has been left, but traces of its matrix on the surface of the last volution lead one to suppose that the present cast is only the inner part of an individual, which in the full-grown state must have reached very considerable dimensions.

In its general shape the shell exhibits the outlines of a typical *Joannites*. The slowly increasing whorls are broadly lenticular, with an equally rounded siphonal area which passes gradually into the lateral parts without forming an edge. The lateral parts are very flatly curved and join the steep umbilical wall in a distinctly marked, sharp edge. The umbilicus is narrow, deep and funnel-shaped. As the involution takes place exactly at the umbilical margin, no strips of the inner whorls are exposed within the umbilicus.

The largest transverse diameter of the shell corresponds with the umbilical margin.

From *C. Oldhami*, Waagen, the present species is distinguished in general shape by its thicker and more rapidly increasing volutions. In *C. Oldhami* the involution is very great, "so much so that nearly two-thirds of the room within the last whorl are filled up by the preceding one." In *C. Walkeri* the siphonal part of the penultimate whorl reaches only one-half of the height in the last volution.

Varices are not distinctly developed. There is one contraction in the anterior portion of the last whorl, which might be considered as an impression of a varix (according to the definition of Suess), but is restricted to one side of the shell only.

The measurements of my type-specimen are as follows :—

| | | |
|---|---|---|
| Diameter of the shell | | 86 mm. |
| " " umbilicus | | 9 " |
| Height of the last whorl | from the umbilical suture | 49 " |
| | " preceding whorl | 26 " |
| Thickness of the last volution | | 36·5 " |

*Sutures.*—The most important character of this species is the sutural line.

The general arrangement is the same as in *Joannites* or in the typical species of *Cyclolobus*, the sutures forming a parabolic arch, which is, however, less strongly curved than in *C. Oldhami*. The whole sutural line is composed of ten lobes and corresponding saddles, which are largest near the siphonal part of the shell and gradually decrease in size as they approach the umbilical margin. The projection of the periphery of the preceding whorl touches the apex of the third lateral saddle in the last volution. The auxiliary series consequently begins at the umbilical side of this saddle. Thus the suture is composed of three lateral and seven auxiliary lobes and corresponding saddles.

The siphonal lobe, which is the largest of all, is divided into two branches by a very large median prominence. This median prominence almost assumes the importance of a saddle proper, is provided with phylloid ornaments, and recalls the strongly developed median prominence in *Joannites*. Each of the two branches of the siphonal lobe is divided by a large monophyllic denticulation. The two portions of the branch adjoining the denticulation are ramified asymmetrically, the outer or siphonal portion being provided with two, the inner or umbilical portion with three, indentations.

The principal lateral saddle is slender, bipartite and of phylloid outlines. The remaining saddles are monophyllic, terminating with a single, undivided, roundish phyllum, whereas their stems are ornamented on both sides with short, small, dentated branches, arranged at right angles to the axis of the saddles.

The lobes are trifid at their base, the median indentation slightly exceeding the two lateral ones in length.

I have not succeeded in developing all the details of the sutural line, but its most important elements, the three principal lobes and saddles, could be made entirely visible near the proximal termination of the last whorl. They differ remarkably from the corresponding sutural elements in *Cyclolobus Oldhami*. It is especially the bipartite character of the principal lateral saddle—corresponding to the siphonal saddles in the majority of ammonites—in which the present species exhibits a close affinity to the triassic genus *Joannites*, Mojs. The oldest representative of this genus, *Joannites proavus*, Diener (Die Cephalopodenfauna der Schiechlinghöhe bei Hallstatt, Beiträge zur Palæont. und Geol. Oesterr.-Ungarns, etc., Bd. XIII, 1900, p. 13, Taf. I, figs. 1, 2), has been noticed by myself in the upper Muschelkalk of the Schiechlinghöhe (zone of *Ceratites trinodosus*) near Hallstatt. The sutural line of this species is unfortunately unknown. A small number of species has been described by E. v. Mojsisovics from the ladinic stage (strata of Buchenstein and Wengen). It is, however, not to these species, but to the geologically younger representatives of the group of *Joannites cymbiformis*, that our specimen appears to be most intimately allied in the character of its principal lateral saddle. Although this saddle is more complicated in its outlines and more richly ornamented in *J. cymbiformis*, it agrees in the slender shape of its stem with *Cyclolobus Walkeri*, whereas in the ladinic species of *Joannites* the saddles are very broad and bulky.

In spite of the bipartite character of its principal lateral saddle, the present species ought, I think, to be left with the genus *Cyclolobus* on account of the monophyllic shape of the remaining sutural elements. It may, however, be taken as a proof of the intimate developmental connection by which *Cyclolobus* is linked as closely to *Joannites*, Mojs., on the one hand, as it is to *Waagenoceras*, Gemmell., on the other.

## GASTEROPODA.

### NATICOPSIS, sp. ind.

This species is represented by four poorly preserved specimens, which neither admit of accurate description nor are worth figuring.

In one of my specimens the smooth, slightly thickened inner lip is accessible to observation, but the rest of the aperture has been entirely broken off. This specimen, which is by far the largest, resembles *Naticopsis Waageni*, Gemmellaro (La fauna dei calcari con Fusulina della Valle del Fiume Sosio, Fasc. II. Palermo, 1889, p. 131, Pl. XVIII, figs. 2, 3), whereas the three smaller specimens recall *Naticopsis minuta*, Gemmellaro (l. c., p. 36, Tav. XV, figs. 5, 6). No identification of the species can, however, be based on such insufficient materials.

## BRACHIOPODA.

### SPIRIFERINA MARGARITÆ, Gemmellaro, Pl. I, fig. 7.

1899. *Spiriferina Margaritæ*, Gemmellaro, La fauna dei calcari con Fusulina della Valle del Fiume Sosio, Fasc. IV, Pte. I, p. 290, Tav. XXX, figs. 9—23.

The identification of the Himalayan shells here under consideration with Gemmellaro's Sicilian species is, I think, perfectly certain. I had for comparison several specimens from the "calcare grossolano" of Pietra di Salomone, which had been collected by my friend Dr. G. von Arthaber. They all agree so very closely with my Himalayan specimens that there can be no doubt as to the identity of the species.

The general outline of my Chitichun specimens is pentagonally oval or circular, the length and breadth of the shell being nearly equal. The hinge-line is shorter than the greatest width of the shell. The species is so variable in thickness, that specimens of a globular shape, of which the thickness is greater than either the breadth or the length, occur together with moderately inflated examples. The two valves are almost equally convex.

The ventral valve is provided with a deep mesial sinus, which begins at the apex, long before any lateral folds are developed. The sinus is not rounded but has a triangular transverse section, being bordered by two evenly converging flanks, which unite in a sharp median edge. In a small number of specimens this median edge is obtusely rounded off. The beak is large, prominent, well incurved and pointed. The area is rather variable in its width, slightly concave, with cardinal angles rounded off and passing very gradually into the lateral parts of the valve. Its triangular fissure is large and marked off from the area by a distinct furrow. There are from four to six radiating ribs on either side of the sinus.

The dorsal valve is barely less inflated than the ventral and is provided with a very small but distinctly developed linear area, which is limited off sharply from the hinge-line. The mesial elevation or fold is broad and considerably elevated above the lateral parts, but obtusely rounded off, not angular like the corresponding sinus in the ventral valve. In some of my specimens the front-margin is slightly produced. The radiating folds, which cover the lateral parts, are of the same pattern as in the ventral valve, varying in their number from four to six, equal in their breadth to the intercostal valleys or furrows, and rounded at their tops.

The surface of each valve is covered with numerous, concentric laminæ, some of which are more prominent than the rest and imbricating.

The internal characters of this species have been studied by Gemmellaro. I have not been able to ascertain them in any of my specimens.

The measurements, taken from two examples of very different size, are as follows:—

| | I. | II. |
|---|---|---|
| Entire length of the shell | 16 mm. | 12 mm. |
| Length of the dorsal valve | 12 „ | 10 „ |
| Entire breadth of the shell | 16·5 „ | 13·5 „ |
| Length of the hinge-line | 12 „ | 8 „ |
| Thickness of both valves | 12 „ | 9·5 „ |

The second specimen is a good representative of Gemmellaro's *Spiriferina Margaritæ var. dilatata.*

*Number of specimens examined.*—12.

*Remarks.*—Gemmellaro considers this species as very nearly allied to *Sp. multiplicata*, Sow. While admitting the relationship between the two species, I am of opinion that to the distinguishing features given by Gemmellaro, the smaller dimensions of *Sp. multiplicata* might be added. The similarity of this group of permian *Spiriferinæ* to the liassic *Spiriferina verrucosa*, to which attention has been drawn by Waagen, seems to me rather distant only, the shape of the mesial sinus and fold making a distinction very easy.

### SPIRIFERINA OCTOPLICATA VAR. FASTIGATA, Schellwien.

1862. *Spiriferina* (?) *subconica*, Mœller, Gornoj journal, St. Petersburgh, vol. VI, Pl. V, fig. 8.

1897. *Spiriferina cristata var. octoplicata*, Diener, The permocarb. fauna of Chitichun No. I, Pal. Ind., ser. XV, Himal. Foss., vol. I, pt. 3, p. 29, Pl. VII, figs. 5—7.

1900. *Spiriferina cristata var. fastigata*, Schellwien, Die Fauna der Trogkofelschichten in den Karnischen Alpen und den Karawanken, Abhandl. K. K. Geol. Reichs.-Anst., Bd. XVI., Heft I, p. 60, Taf. XI, figs. 1—3.

In 1900 Professor Schellwien described and figured a few specimens of the widespread *Spiriferina cristata*, Schloth., from the permo-carboniferous rocks of Carniola under the new varietal designation of *fastigata*. They represent an exceptional shape of *Sp. cristata*, which though being very closely allied to the carboniferous *Spiriferina octoplicata*, Sow., is distinguished from typical forms of the latter species by its broad and sharp triangular mesial fold, and still more by the shape of the corresponding sinus, which is very strongly produced beyond the front-line.

Schellwien has been perfectly right in stating that my specimens of *Sp. octoplicata* from the permian limestone crag of Chitichun No. I must be united with his new variety, their lower area and more strongly incurved beaks not being distinctive features of any importance. I am quite of his opinion and shall consequently admit the new denomination "*fastigata*" as a varietal designation for my Himalayan shells.

I am, however, not disposed to class *Spiriferina Margaritæ var. consanguinea*, Gemmellaro, among the varieties of *Sp. octoplicata* or *cristata*, as has been proposed by Schellwien. My specimens of *Sp. Margaritæ* from Chitichun

No. I differ remarkably from *Sp. octoplicata var. fastigata* in their less transversely elongated shape, the rounded-off cardinal angles and the little produced sinus of the ventral valve. Most of these criteria of distinction hold good also in *Sp. Margaritæ var. consanguinea*, which, moreover, differs from my specimens of *Sp. octoplicata* in the broader, smooth mesial portion, and the narrower, more densely packed folds on the lateral parts of the shell.

### SPIRIFER TIBETANUS, Diener.

1897. *Spirifer tibetanus*, Diener, The permocarb. fauna of Chitichun No. I, Pal. Indica, ser. XV, Himalayan foss., vol. I, pt. 3, p. 45, Pl. VI, figs. 1—7.

1900. *Spirifer tibetanus var. occidentalis*, Schellwien, Die Fauna der Trogkofelschichten in den Karnischen Alpen und den Karawanken, Abhandl. K. K. geol. Reichs.-Anst., Bd. XVI, Heft. 1, p. 76, Taf. XI, figs. 10—13.

1901. *Spirifer lyra mut. tibetica*, Frech, Die Dyas, Lethæa palæozoica, II, Bd. 3, Liefg., p. 501.

Having sent Himalayan specimens of this shell to Prof. Schellwien in Kœnigsberg, they were declared to be identical with a species collected by him in the permo-carboniferous limestone of Neumarktl in Carniola. Prof. Schellwien, however, considers this species to be sometimes with difficulty, and even uncertainty, distinguishable from certain shapes of *Sp. lyra*, Kutorga, and of *Sp. Parryanus*, Toula. Prof. Frech in his list of the permian fossils from Chitichun No. I, published in 1901, even places *Sp. tibetanus* among the synonyms of *Sp. lyra*, and believes it to be only a modification of Kutorga's Russian species.

Prof. Schellwien's suggestion that *Spirifer tibetanus* might perhaps prove to be a mere modification of *Sp. Parryanus*, Toula, is, I fear, a mistake, and a comparison of the original specimens of both species has led me to a different conclusion. By the kindness of Dr. Th. Fuchs, Director of the Geological Department of the Imperial Museum of natural history in Vienna, I have been permitted to examine the specimen from Hinlopen Straits in Spitzbergen, which has been described and figured as *Spirifer Parryanus* by Toula in his memoir on "Permo-carbonfossilien von der Westkueste von Spitzbergen" (Neues Jahrb. f. Min., etc., 1875, p. 256, Taf. VII, fig. 8). The name of this species must be changed, since the priority of the denomination of *Sp. Parryanus* is claimed by a species from the devonian rocks of Iowa, described in 1858 by Prof. I. Hall (Rep. on the Geol. Surv. of Iowa, vol. I, pt. 2, Palæontology, p. 509, pl. IV, fig. 8), as has been stated in my memoir on the Anthracolithic fossils of Kashmir and Spiti (l. c., vol. I, pt. 2, p. 68). The materials of *Spirifer Loveni*, which name I ventured to propose for Toula's species, consist of three ventral valves only. Whether the dorsal valve, marked erroneously as fig. 7 instead of 8*d* on Plate VII of Toula's memoir, actually belongs to the same species, is yet doubtful. Its illustration by the draughtsman is entirely misleading, the reconstructed wings not being preserved in the original specimen.

The ventral valve of *Spirifer Loveni* differs from *Sp. tibetanus* not only in its longer hinge-line, as has been supposed by Schellwien, but also by a less prominent tendency to develop secondary ribs originating from the primary costæ. In *Sp.*

*tibetanus* each lateral rib is subdivided into two or three smaller ones of irregular strength and width, beyond the apical region. In *Sp. Loveni* this ornamentation is confined to the primary ribs bordering the mesial sinus, whereas in the adjacent costæ secondary ribs are noticed in the immediate vicinity of the front-margin only.

Schellwien and Frech, by an examination of examples of *Spirifer lyra*, Kut., have been led to infer that *Sp. tibetanus* is perhaps only a modification of the former species. I fear, indeed, that I may have too hastily excluded *Sp. lyra* from the nearest allies of my Himalayan species, chiefly on account of the absence of a narrow but distinct rib in the centre of the sinus in Kutorga's type-specimen, as represented in the very bad figure of his memoir on the palæontology of Russia (Verhandlungen der kais. Russischen Mineralog. Gesellsch. zu St. Petersburg, 1877, p. 92, pl. IX, fig. 7). Prof. Schellwien, however, notes the presence of a thin median fold in the sinus of one of the specimens of *Sp. lyra*, which had been collected by Wangenheim von Qualen in the upper carboniferous Schwagerina limestone of the Ural Mountains. On the other hand, he drew attention to the presence of more than two ribs in the flat mesial fold of the dorsal valve and the greater width of the shell in his two Russian examples.

Most palæontologists will, I think, agree with me in the opinion, that from the badly drawn illustrations of *Sp. lyra* in Kutorga's memoir, an identification of this species with my *Sp. tibetanus* is utterly impossible. Without insisting on more minute differences, I must lay a special stress on one feature which seems to have been overlooked both by Schellwien and Frech. This is the remarkable difference in the shape of the beaks in *Sp. lyra* and in *Sp. tibetanus.*

In the dorsal valve of *Sp. tibetanus* the beak is barely raised above the hinge-line, having only a very small, though distinctly developed, area. In the dorsal valve of *Sp. lyra*, on the contrary, the beak is so strongly elevated, that in the dorsal view of Kutorga's type-specimen the triangular fissure of the ventral area is entirely concealed by the apex of the opposite valve. It only needs a comparison of the lateral view of the type-specimens of both species, as given in fig. 7*c* of Kutorga's memoir and in figs. 1*c*, 2*c* and 4*c* of my monograph on the Chitichun fossils, to notice this remarkable difference.

The importance of this character in *Sp. lyra* is confirmed by Kutorga's description. He explicitly draws attention to the presence of a long, incurved beak in the dorsal valve " which strives to reach the beak of the opposite valve." Neither Schellwien nor Frech hint at this character of the beaks in their two Russian examples, which are supposed, rightly or wrongly, to belong to the same species as Kutorga's type. It is probably through having overlooked this circumstance, that Prof. Frech confused the two shells, whereas their relationship was overrated by Schellwien, who, more cautious than his friend, did not venture to decide the question of identity of *Sp. lyra* and *Sp. tibetanus.*

From such insufficient data as Kutorga's illustration and description of *Spirifer lyra* it would be hardly safe to reduce *Sp. tibetanus* to the rank of a variety of the Russian species. I consequently prefer to retain *Sp. tibetanus* as a distinct species, notwithstanding Prof. Frech's statement to the contrary. My view is confirmed by Prof. Tschernyschew, who informs me that both species are represented among his materials from the upper carboniferous Schwagerina-limestone of the Urals, and are readily distinguishable by constant characters.

### RETICULARIA cf. LINEATA, Martin.

1897. *Reticularia lineata*, Diener. The permocarb. fauna of Chitichun No. I, Pal. Ind., ser. XV, Himalayan Foss., vol. I, pt. 3, p. 56, pl. IX, figs. 5, 6, 8. *Cf. R. affinis*, Gemmellaro. La fauna dei calcari con Fusulina della valle del F. Sosio, Fasc. IV, Pte. I (1899), p. 330, Pl. XXXIV, figs. 5—8, XLVI figs. 10, 11.

Since my description of *Reticularia lineata* from the permian limestone crag of Chitichun No. I was written, the question has been raised by several palæontologists as to whether the Himalayan shells really belonged to Martin's species.

Gemmellaro observes that the specimens, which have been figured on Plate IX of my above-quoted memoir, are more similar to his *Reticularia affinis*, and that he only abstains from identifying them with the latter species on account of my statement that their sculpture is exactly the same as in European specimens of *Reticularia lineata* from the mountain limestone of England and Belgium. Schellwien, in his monograph on the permo-carboniferous fauna of the Trogkofelschichten in Carinthia and Carniola (Abhandlungen K. K. Geol. Reichs-Anst., Bd. XVI, p. 83), likewise alludes to the possibility of separating some of my Himalayan examples from the true *R. lineata* as distinct species. G. von Arthaber (Beiträge zur Palæont. und Geologie Oesterreich-Ungarns, etc., Bd. XII, p. 269) denies the identity of the specimen represented on Plate IX, fig. 6, with *R. lineata*, and comes to the conclusion that it ought to be identified with *R. Waageni*, Lóczy.

I do not wish at present to enter into further details with reference to all the species of *Reticularia*, which may possibly be distinguishable among the rich materials from Chitichun No. I. I am still of opinion that all the examples which have been illustrated in my above-quoted memoir, should be referred to two species only, to *R. pulcherrima*, Gemm., and to a second species, which has been previously identified with *R. lineata*, Mart. But I am no longer so convinced that this latter identification is strictly correct.

If we compare the type of shells, of which fig. 5 on Plate IX of my memoir on the Chitichun fauna is a faithful representation, with *R. affinis*, Gemm., their external similarity is obvious. They differ from the types of *R. lineata*, as figured by Davidson, by their more strongly inflated valves, by a more prominent apex of the dorsal valve and by the absence of any distinctly defined lateral margins in the ventral area. But all these characters of distinction are of very little importance if we solely regard the fact that more difference is shown between the greater number of typical specimens of *R. lineata* themselves, than is here represented between *R. lineata* and *R. affinis*. Nor has the denomination of *R. affinis* been introduced by Gemmellaro for his Sicilian species on the strength of such minute details, but on account of its remarkable sculpture.

Gemmellaro's description of the ornamentation in *Reticularia affinis* runs as follows: "The surface of my type-specimens is ornamented with concentric rings, which are close, regular, convex and almost angular in the middle, and resulting from two systems of radial striæ, one of them inclined to the apex and the other to the front. The striæ are very delicate, hair-like and packed very closely together. Occasionally radial striæ of different length are met with, which intersect the concentric rings."

Notwithstanding this lengthened description I cannot perceive any valid difference in the ornamentation of *R. affinis* and *R. lineata*. While speaking of *R. lineata* Prof. Davidson observes that in different examples the radiating striæ and concentric lines or ridges are extremely variable in their degree of strength and proximity. Thus the very close arrangement of the concentric rings, as exhibited in Gemmellaro's illustrations of *R. affinis* and in some of my Chitichun specimens, is certainly no character of any real permanency.

Another difference, on which stress has been laid by Gemmellaro, is the almost angular character of the concentric rings in the middle, "resulting from two systems of radial striæ, one of them inclined to the apex and the other to the front." It is, unfortunately, not possible to detect this character in the figures represented on Plate XXXIV of Gemmellaro's memoir. From his description (p. 331) he seems to have selected a special figure (Taf. XLVI, fig. 11) for the illustration of the details in the surface-sculpture of *Reticularia affinis*, but the part of his monograph containing this plate has not yet been published.

It were to refuse the evidence of my eyes if I should say that any of my specimens from Chitichun No. I could be distinguished from the common *R. lineata* by their peculiar ornamentation. But I must hasten, at the same time, to observe that the majority of Himalayan specimens in their general shape do not, indeed, entirely agree with Martin's species. All the British types of *R. lineata* which have been figured by Davidson (Monograph of the British Carbon. Brachiopoda, p. 63, Pl. XIII, figs. 1—13), notwithstanding their great variability, are either transversely oval or sub-orbicular. Among the Himalayan representatives of the sub-genus *Reticularia*, sub-orbicular shapes, such as the specimens illustrated in fig. 5, are an exception, the majority being distinguished by elongately oval outlines. But sub-orbicular and elongately oval shapes are most intimately connected by intermediate forms, which appear to merge the one into the other.

If the elongately oval outline prevailing in my Himalayan examples should be considered to be of specific value, the form from Chitichun No. I might be separated from *R. lineata*, although the general character in both is specifically the same. The question of their identity with *R. affinis* must, for the present, remain open.

G. von Arthaber denies the identity of the specimen, illustrated on Plate IX, fig. 6, of the third part of the present volume, with the rest of my Himalayan examples, and believes it to be specifically identical with *R. Waageni*, Lóczy. I do not feel disposed to agree with him in this matter.

L. v. Lóczy in his monograph on the palæontological collections made during the expedition of Count Széchenyi in Eastern Asia (Wissenschaftliche Ergebnisse der Reise des Grafen Béla Széchenyi in Ostasien, III, Bd. IV, Abthlg., Buda-Pest, 1898, p. 110, Taf. IV, figs. 1, 2) introduced his new species for two ventral valves of uncommonly large size, provided with a very large, triangular fissure, a comparatively small beak, and a peculiar ornamentation, distinguished by a remarkable difference in the distance of the concentric rings in the apical and frontal regions. The identity of the Armenian species from Djulfa and of the specimen figured by Kayser in Richthofen's "China" (vol. IV, Pl. XXII, fig. 8)[1] with Lóczy's species is certainly complete, but the correctness of its identification with my Himalayan example must be denied. None of the many specimens of *Reticularia* from Chitichun No. I that have come under my observation attained the dimensions of the smallest *Reticularia Waageni*. Size alone, however, cannot be made use of as a distinguishing character between species which otherwise resemble each other. But the external resemblance of my Chitichun specimens to *R. Waageni* is only distant. Neither the sub-quadrate outline, resulting from the very obtuse apical angle, nor the difference in the proximity of concentric rings on the surface of the shells, which are the most remarkable characters in *R. Waageni*, have been noticed in any of my Himalayan specimens.

It is therefore evident that *Reticularia Waageni*, Lóczy, is not represented among the fauna of the permian limestone crag of Chitichun No. I.

### RETICULARIA PULCHERRIMA, Gemmellaro, Pl. I, fig. 5.

1897. *Reticularia lineata*, Diener. The permo-carbon. Fauna of Chitichun No. I, Pal. Indica, ser. XV, Himalayan Foss., vol. I, pt. 3, p. 56, Pl. IX, fig. 7 (non figs. 5, 6, 8).

1899. *Reticularia pulcherrima*, Gemmellaro. La fauna dei calcari con Fusulina della Valle del Fiume Sosio. Fasc. IV, Pte. I, p. 332, Taf. XXXIV, figs. 21—29.

1899. *R.* cf. *pulcherrima*, G. v. Arthaber. Über das Palæozoicum in Hocharmenien, etc., Beiträge zur Palæont. u. Geol. Oesterreich-Ungarns, etc., XII, p. 268, Taf. XX, fig. 13, 14.

The group of *Reticularia lineata*, Mart., is one of the most extensive of carboniferous and permian groups of fossils. In my memoir on the fauna of Chitichun No. I I included all the numerous representatives of the sub-genus *Reticularia* in the single species *R. lineata*, adopting the view of Professor Davidson, who had united all the congeneric shells of carboniferous age under the single denomination of *Spirifera lineata*, Mart. While describing the materials from the permian limestone of Chitichun No. I, which had been collected by Griesbach, Middlemiss and myself, I did not omit to refer to the various difficulties in the way of a satisfactory determination of the species of *Reticularia*, but, as the true *R. lineata* undoubtedly ranges from the lowest carboniferous into permian strata, their distinction did not appear to me of great geological importance.

In his monograph on the fauna of the permian Sosio limestone of Sicily, Gemmellaro introduced five new species of *Reticularia* which, according to his view, are clearly defined and must be distinguished from Martin's type. Thus it seems necessary to modify my former opinion, as the present material affords evidence that among the *Reticulariæ* from Chitichun No. I a number of different shapes may indeed be distinguished. The uncertainty in regard to the specific value of these shapes is, however, far from having been cleared up, and it is only with great reserve that I agree with Professor Gemmellaro in considering ***Reticularia pulcherrima*** and ***R. inæquilateralis*** as distinct species. But since the majority of palæontologists seem inclined to accept a very narrow circumscription in the interpretation of species of Brachiopoda, I have described them separately and must leave for future observers to determine whether or not this is to be taken as a correct interpretation. From Gemmellaro's and G. von Arthaber's descriptions it will be perceived that the most important distinctions which these two authors suggest between ***Reticularia pulcherrima*** and *R. lineata*, are the following :—

---

[1] G. Fliegel, "Ueber obercarbonische Faunen aus Ost-und Suedasien." Palæontographica, 48, Bd. 1901, p. 131.

***Reticularia pulcherrima*** is elongately-oval, with very strongly, but equally inflated, valves. The beak of the ventral valve is very prominent, pointed, strongly incurved, but not approximate to the apex of the dorsal valve, which is much more strongly inflated and appressed to the hinge-line. The two valves are uniformly convex, a sinus and corresponding elevation being apparent only near the front.

Among Walker's materials from Chitichun No. I this type is represented by four specimens, which indeed bear so little external resemblance to any of the shapes of *Reticularia lineata*, that, until better evidence to the contrary arises, I have considered it desirable to separate them from the last-named species.

The specimen, of which an illustration is given on Plate I, fig. 5, differs from Gemmellaro's Sicilian examples in the presence of a ventral area, which is separated from the remainder of the shell by indistinct edges.

In this character it agrees with the Armenian examples from the Otoceras beds of Djulfa, which have been described by G. von Arthaber. But this difference loses much of its importance from the fact that in the rest of my specimens the lateral margins of the area are quite as ill-defined as in Gemmellaro's examples from the Sosio limestone of Sicily.

The specimen, figured on Plate IX, fig. 7, of my memoir on the fauna of Chitichun No. I, must undoubtedly be identified with the present species.

My specimens are all small. The measurements of my largest example are as follows :—

| | |
|---|---|
| Entire length of the shell . . . . . . . . . . | 18 mm. |
| Length of the dorsal valve . . . . . . . . . . | 15 ,, |
| Entire breadth of the shell . . . . . . . . . . | 13·5 ,, |
| Length of the hinge-line . . . . . . . . . . | 9 ,, |
| Thickness of both valves . . . . . . . . . . | 15 ,, |

*Remarks.*—***Reticularia pulcherrima*** is a species of exclusively permian age, having been recorded hitherto only from the Fusulina limestone of Sosio and from the permian Otoceras beds of Djulfa.

### RETICULARIA INÆQUILATERALIS, Gemmellaro, Pl. I, fig. 6.

1899. *Reticularia inæquilateralis*, Gemmellaro. La Fauna dei calcari con Fusulina della valle del F. Sosio, Fasc. IV, Pte. I, p. 336, Taf. XXXV, figs. 2—21; Taf. LXVI, fig. 13.

The external characters of this remarkable species have been fully described by Gemmellaro. Its most important feature is the asymmetrical shape of the valves and the position of the apex, which is shifted either to the left or right side of the shell.

The specific claims of *Reticularia inæquilateralis* will certainly be the subject of considerable difference of opinion. Palæontologists may be inclined to consider the asymmetry in the shape of the valves and in the position of the beaks as pathological characters only. This seems to be Dr. G. v. Arthaber's view, who, in his memoir on the palæozoic rocks of Djulfa (l. c., p. 269), has placed *R. inæquilateralis* among the synonyms of *R. Waageni*, Lóczy. Great stress must, however, be laid on the very large number of specimens by which the species is represented in the permian Fusulina limestone of Sicily at different localities, as Passo di Burgio, Rocca di San Benedetto, Pietra di Salomone. Nevertheless it remains still to be ascertained whether this asymmetry can be considered as a feature common to the species or peculiar only to some specimens which belong to different groups.

Two specimens among the *Reticulariæ* from Chitichun No. I I leave provisionally with *R. inæquilateralis* until richer materials admit of a more correct classification of the numerous species of this sub-genus. In both of my specimens the beaks are shifted considerably towards the right, the specimens having been placed in their proper position, front-margin upwards. Thus the flanks of the beaks are of a very different length, one of them being limited by concave, and the other by convex, outlines. In the figured specimen the beaks of the two valves approach one another. In my second specimen the beak of the ventral valve has not been preserved. A sinus and corresponding mesial elevation are only slightly developed. They do not occupy the middle portion of the front-margin, but are shifted to the left, thus corresponding to the position of the beaks. The lateral margins of the area are not distinctly defined.

The surface of the shell is not sufficiently well-preserved to exhibit anything more than numerous concentric lines of growth, which are a common feature of the sub-genus *Reticularia*.

### SPIRIGERA (ATHYRIS) EXPANSA, Phillips, Pl. I, fig. 4.

1836. *Spirigera expansa*, Phillips. Geology of Yorkshire, vol. II, p. 220, Pl. X, fig. 18.
1840. *Atrypa expansa*, Sowerby. Min. Conch., Pl. DCXVII, fig. 1.
1840. *Atrypa fimbriata*, Sowerby, (non Phillips) *ibid.*, fig. 4.
1857. *Athyris expansa*, Davidson. Monograph, British Carboniferous Brachiopoda, Transac. Palæontographical Soc., vol. X, p. 82, Pl. XVI, figs. 14, 16—18; Pl. XVII, figs. 1—5.
1888. *Athyris expansa*, Krotow. Mém. com. Géol de la Russie, K. Pétersbourg, vol. VI, p. 421.
1899. *Athyris cf. expansa*, Diener. Anthracolithic Fossils of Kashmir and Spiti, Pal. Indica, ser. XV, Himalayan Fossils, vol. I, pt. 2, p. 53, Pl. VI, fig. 11.

A single tolerably well preserved specimen agrees so completely in all its characters with *Spirigera expansa*, that I do not hesitate to refer it to this carboniferous species.

It is transversely elliptical, considerably wider than long, but remarkably asymmetrical. In its state of malformation it resembles the type which has been figured by Davidson on Plate XVII, fig. 1, of his monograph on British carboniferous Brachiopoda. The two valves are equally and moderately convex and as strongly inflated as the majority of type-specimens of *Spirigera planosulcata*, Phill. The beak is moderately produced, incurved and truncated by a small foramen. Whether it was contiguous to the umbo of the dorsal valve cannot be made out with certainty, the latter having been partly injured by weathering. Neither a mesial sinus in the ventral valve nor a corresponding fold in the opposite one have been noticed. This absence of a sinus in the ventral valve forbids an identification of the present specimen with *Sp. subexpansa*, Waagen (Salt Range Fossils, Pal. Ind., ser. XIII, vol. I, Prod. limest. foss., p. 478).

The ornamentation of the shell is incompletely preserved. It consists of numerous concentric lines of growth. Traces of indistinct radiating striæ can be seen on the lateral parts of the dorsal valve. Shelly fringes or lamelliform expansions have not been noticed.

It is difficult to convey a correct idea of the dimensions of this shell by actual measurements, as the two valves gape at the front-margin. Their thickness, therefore, cannot be measured exactly.

The measurements of the figured specimen are as follows:—

| | |
|---|---|
| Entire length of the shell | 26 mm. |
| Length of the dorsal valve | 23 „ |
| Entire breadth of the shell | 36 „ |
| Thickness of both valves | ab. 19 „ |

The recurrence of *Spirigera expansa* in beds of permian age adds one more species to the considerable number of Brachiopoda, which appear to be common to the carboniferous and permian systems.

### RETZIA (HUSTEDIA) GRANDICOSTA, Davidson (=RETZIA REMOTA, Eichwald), Pl. II, figs. 8, 10.

1860. *Rhynchonella remota*, Eichwald. Lethæa Rossica, vol. I, p. 768, Pl. XXXV, fig. 10.
1862. *Retzia radialis var. grandicosta*, Davidson. Quart. Journ. Geol. Soc., London, vol. XVIII, p. 28. Pl. I, fig. 5.
1863. *Retzia radialis var. grandicosta*, Davidson. L. de Koninck, Mémoire sur les fossiles paléozoiques requeillis dans l'Inde, p. 33, Pl. IX, fig. 5.
1882. *Retzia compressa*, Kayser (*non* Meek). Obercarbonische Fauna von Loping, Richthofen's China, IV Bd., p. 176, Taf. XXII, figs. 1—4.
1884. *Eumetria grandicosta*, Waagen. Salt Range Fossils, Palæont. Indica, ser. XIII, vol. I. Prod. Limest. Foss., p. 491, Pl. XXXIV, figs. 6—12.
1890. *Retzia grandicosta*, Nikitin. Mém. Com. géol. de la Russie, St. Pétersbourg, vol. V, No. 5, p. 68, Pl. III, figs. 9—11.
1892. *Retzia grandicosta*, Rothpletz, Die Perm.-Trias.-und Juraformation auf Timor und Rotti, Palæontographica, 39 Bd., p. 83, Taf. X, fig. 11.

1898. *Eumetria cf. grandicosta*, Loczy. Wissenschaftliche Ergebnisse der Reise des Grafen Béla Széchenyi in Ostasien, III, Bd. IV, Abtteilg., p. 95, Taf. II, fig. 13.

1899. *Eumetria cf. grandicosta*, Diener. Anthracolithic Fossils of Kashmir and Spiti, Palæont. Ind., ser. XV, Himálayan Foss., vol. I, pt. 2, p. 54, Pl. VI, fig. 10.

1900. *Retzia, cf. grandicosta*, Enderle. Ueber eine anthracolithische Fauna von Balia Maaden in Kleinasien Beiträge zur Palæontologie und Geologie Oesterreich-Ungarns, etc., Bd. XIII, p. 92.

1900. *Retzia (Hustedia) cf. grandicosta*, Schellwien. Die Fauna der Trogkofelschichten in den Karnischen Alpen und den Karawanken, Abhandl. K. K. Geol. Reichs. XVI, Bd., p. 91, Taf. XIV, fig. 5.

1901. *Hustedia grandicosta*, Fliegel. Ueber obercarbonische Faunen aus Ost.-und Suedasien, Palæontographica, 48 Bd., p. 132.

Of this species, which had hitherto been unknown from the permian limestone crag of Chitichun No. I, a small number of specimens was collected by Walker.

All my specimens agree well with the descriptions and figures which have been given by Waagen and Nikitin. Both valves are elongately oval and moderately inflated—not globose. The ventral valve is provided with a small, triangular area, in which no deltidium is noticed. The slender beak is somewhat produced, straight, but slightly incurved and considerably distant from the apical part of the dorsal valve.

Neither sinus nor median fold are developed. Each valve is ornamented with eleven to twelve strong, radiating ribs. The intercostal depressions or furrows are broader than the ribs and divided occasionally by very delicate, threadlike elevations, which run parallel to the principal ribs. These secondary radiating elevations are only observed in casts, and are not visible when the shell of the specimen has been preserved. The latter exhibits a very distinct concentric striation in the vicinity of the front-margin, and the punctate shell-structure, which is characteristic of the genus *Retzia*.

The measurements of the figured specimen are as follows:—

| | |
|---|---|
| Entire length of the shell . . . . . . . . . . | 10 mm. |
| Length of the dorsal valve . . . . . . . . . . | 8·5 „ |
| Entire breadth of the shell . . . . . . . . . . | 8 „ |
| Thickness of both valves . . . . . . . . . . | 5 „ |

In one of my specimens (fig. 10) the internal characters have been partly made visible by grinding off a portion of the dorsal valve. In the figure the presence of two spiral cones and of a stout cardinal process or hinge-plate is exhibited.

*Number of specimens examined.*—3.

*Remarks.*—Of the external characters of my specimens the most striking are the elongately oval shape and the moderate inflation of the shell, the strong radiating costæ and the absence of any sulcus or corresponding mesial elevation in the central portion of the two valves. From *Retzia radialis*, Phill., they can be distinguished by all the differences which have been enumerated by Waagen, although the majority of those characters of distinction are not considered by Nikitin as permanent in his Russian examples.

The Chinese specimens, which have been confounded with *Retzia compressa*, Meek, by Kayser, but are identified with *Retzia grandicosta* by Fliegel, may, however, be distinguished from my Himalayan examples by their more globose shell and by the shape of the beak, which is thick, stout, and barely bent over. Without wishing to deny the correctness of Fliegel's identification, I am therefore not disposed to accept it without some reserve.

In size and number of ribs my Himalayan specimens agree perfectly well with Nikitin's type-specimens from Gshel and with Lóczy's Chinese examples from Kansu. Waagen's Indian specimens from the Salt Range Productus limestone are a little larger (length 14 mm., breadth 10 mm.), and are provided with one or two more ribs.

The specimen from the permian rocks of Timor, which has been described and figured by Rothpletz, is distinguished from the typical *Retzia* (*Hustedia*) *grandicosta* by a smaller number of ribs (7). But the character of the radiating rounded costæ is the same, notwithstanding the variability of their number.

The group of *Retzia grandicosta*, which had been classed under the genus *Eumetria* by Waagen, has more recently been removed from this genus and elevated to the position of prototype of a proper genus, *Hustedia*, by Hall and Clark (Introduction to the Study of Genera of Palæozoic Brachiopoda, Geological Survey of New York, Palæontology, vol. VIII, pt. II, p. 120). Prof. Hall observes that the various species from the St. Cassian beds in the Trias of South-Eastern Tirol, which have been referred to the genus *Retzia* by Bittner, probably have their closest relations with *Hustedia*. "These are", he states, "for the most part coarsely ribbed forms, some of them with extravagantly high areas. Their internal structure has not been satisfactorily demonstrated."

Bittner, in his monograph of Alpine triassic Brachiopoda (Abhandlungen K. K. Geol. Reichs-Anst., XIV Bd., p. 294), likewise alludes to the close relationship of the majority of triassic *Retziæ* to Waagen's genus *Eumetria*. Some of the species from the Alpine Muschelkalk, as *Retzia speciosa*, Bittn., or *R. Mojsisovicsi*, Bœckh, bear even a greater external resemblance to *Hustedia grandicosta* than *H. radialis* or *H. ulotrix*.

*Hustedia grandicosta*, Dav., has been united with *H. remota*, Eichwald (Lethæa Rossica, vol. I, p. 768, Pl. XXXV, fig. 10), by Frech (Die Dyas, Lethæa palæozoica, II, Bd. 3, Lfg., Explanation of Pl. 57*b*). This view is not in accordance with Nikitin's remarks, who states that at the locality at which *Rhynchonella remota* had been said to occur by Eichwald, no beds younger than limestones of devonian age are known. The figures which have been published by Eichwald are too unsatisfactory to give any clue to the identification of *Hustedia grandicosta* and *H. remota*. For clearing up this uncertainty I am obliged to my distinguished friend Prof. Tschernyschew, who declares the two species to be identical.

"After having examined and compared", he writes, "a number of Uralian and Indian examples of these two so-called species, I have come to the conclusion that there is no specific difference between them. Eichwald's type-specimen was not collected from the devonian rocks of Kushwa, as was supposed by Nikitin, but from the upper carboniferous limestone in the vicinity of Sterlitamak. In Eichwald's descriptions the localities given are often misleading. In many cases on his labels the name of Kushwa must be replaced by Sterlitamak. It is very difficult to get a clear idea of the true character of *Hustedia remota* from Eichwald's illustration, because his type-specimen was a cast, devoid of its shelly substance."

From this statement it is evident that the two species are really identical. The term "*remota*", from having been first proposed, should be employed for both, and that of "*grandicosta*" be placed among the synonyms. It might, however, be considered advisable to raise the question whether in such an exceptional case we ought to adhere to the strict principles of priority and not retain the name "*grandicosta*", as it was proposed for a species of which the exact horizon had been determined, along with a much better description and with a correct knowledge of the affinities of the shell.

### UNCINELLA cf. INDICA, Waagen, Pl. II, fig. 9.

1883. *Uncinella indica*, Waagen. Salt Range Fossils, Palæontologia Indica, ser. XIII, vol. I, Productus Limestone Fossils, p. 795, Pl. XXXV, fig. 3.

This rare species, occurring in the Katta beds of the middle division of the Salt Range Productus limestone, is probably represented among the Chitichun fauna by a single but well-preserved specimen of small size.

The development of the external characters of the shell is very similar to that of *Uncinella indica*, Waagen. My type-specimen is elongately oval and of considerable thickness. The ventral valve is strongly inflated and slightly more convex than the opposite one. Its greatest convexity corresponds to the region between the middle and umbonal portions of the valve. The beak is very thick, strongly bent over, and truncated obliquely by a large oval foramen, and so firmly appressed to the apex of the dorsal valve, that the latter is partly concealed.

On both sides of the beak smooth spaces are noticed without radiating plications. As they are not limited off from the lateral parts of the ventral valve, but gradually pass into them, they can barely be considered as forming a false area. The front-margin is almost straight, no sinus or corresponding median fold being developed. The lateral margins of the two valves meet in a straight but slightly denticulate line.

Each valve is covered with a large number of delicate, radiating plications which are most strongly marked in the vicinity of the front-margin.

The measurements of this specimen are as follows :—

| | |
|---|---|
| Entire length of the shell | 7 mm. |
| Length of the dorsal valve | 5 „ |
| Entire breadth of the shell | 5 „ |
| Length of the hinge-line | 4 „ |
| Thickness of both valves | 5 „ |

My specimen is a cast, with very few traces of its shelly substance preserved. I have not been able to observe the punctate structure of the shell.

In its external characters my specimen cannot be distinguished from *Uncinella indica* except by its much smaller dimensions. There are especially all the features of generic importance, which it has in common with the latter species. Such features are the absence of an area on the dorsal side of the ventral valve, the thick beak, which partly covers the apex of the dorsal valve, the ornamentation of the shell, and the perfectly straight line, in which both valves meet. The great variability of dimensions in *Betzia* and other closely allied genera of *Helicopegmata*is a well-known fact. I am consequently doubtful as to the specific value of this character, and will provisionally refer my specimen to *Uncinella indica.*

*Betzia himaica*, Bittner (Himalayan Fossils, Palæont. Indica, ser. XV, vol. III, pt. 2, p. 22), from the lower Muschelkalk of the Himalayas, somewhat recalls the genus *Uncinella* by the slight development of its area and by the absence of any median elevation in the dorsal valve.

### ENTELETES WAAGENI, Gemmellaro.

1897. *Enteletes Tschernyscheffi*, Diener, *ex parte*. The permocarb. Fauna of Chitichun No. I, Pal. Indica, ser. XV, Himalayan Foss., vol. I, pt. 3, p. 67, Pl. V, fig. 11 (*non* figs. 7—10).

1899. *Enteletes Waageni*, Gemmellaro. La fauna dei calcari con Fusulina della Valle del F. Sosio, fasc. IV, pt. I, p. 280, Taf. XXVIII, figs. 13—15; XXIX, figs. 16—27.

1899. *Enteletes sp. ex aff. Kayseri*, Semper, *ex parte*. Ueber Convergenzerscheinungen bei fossilen Brachiopoden, Neues Jahrb. f. Min. p. 253, Taf. XV, figs. 1—4.

It is to be regretted that my memoir on the fauna of Chitichun No. I had been published before Gemmellaro's descriptions of the permian Brachiopoda of the Fusulina limestone of Sicily could be obtained. It would certainly have been more agreeable and advantageous if the introduction of synonyms such as *Enteletes Tschernyscheffi* had thus been obviated and a closer comparison of the two faunæ rendered possible.

In my monograph on the Chitichun fauna all the representatives of the genus *Enteletes*—the denomination *Enteles* (Frech-Schellwien) must be rejected as incorrect—were united in a single species, for which the name *Enteletes Tschernyscheffi* has been proposed. In Gemmellaro's memoir the name *E. Tschernyscheffi* is applied to a very different species. Gemmellaro (l. c., p. 305), however, insists on retaining this name for his Sicilian species and proposes to change the denomination of the Himalayan species into *E. Dieneri*, claiming to have assigned the name to his species in 1892 (Bollettino Soc. scienze nat. ed econom. di Palermo, No. 3, p. 24). But such procedure is in contradiction to the laws of priority, neither any description nor illustration of his *E. Tschernyscheffi* having been published in 1892, whereas in 1897 my Himalayan species was accurately illustrated and characterized. Thus I am compelled to supersede Gemmellaro's term and to retain the name of *E. Tschernyscheffi* for the Himalayan species from the permian limestone crag of Chitichun No. I.

The number of species belonging to the group of *Enteletes hemiplicatus*, Hall (*rentrisinuati*, Waagen), has been extraordinarily multiplied by Gemmellaro's researches, but the species, which have been introduced by this learned author, are so narrowly restricted that their specific distinction is based on the most subordinate details. The propriety of admitting all those new species is certainly questionable, but, on the other hand, palæontologists ought, I think, to hesitate to discard species without having at hand for comparison the materials on which they have been based. As a critical examination of the permian Brachiopoda of Sicily is, for the moment, impossible to me, the only thing I can do is to find out whether any of the new species introduced by Gemmellaro might be distinguished among my Himalayan materials. But I do not wish to comment on their specific claims. It is, however, with much doubt and many misgivings that I here provisionally admit the majority of Gemmellaro's new species of *Enteletes*.

Gemmellaro (l. c., p. 305) objects to an identification of the specimen represented on Plate V, fig. 11, of my memoir with *Enteletes Tschernyscheffi*, Diener, but prefers to consider it as a young example of his *E. Waageni*. After having obtained a second larger specimen of the same type from Walker's materials, I am rather inclined to follow Gemmellaro's view. Thus *Enteletes Waageni* is represented in the Chitichun collection by two larger (dorsal) valves, which in their external characters agree with Gemmellaro's type-specimens from the Sosio limestone, but are somewhat inferior to them in size.

As characters of distinction the following may be enumerated: The very remarkable convexity of the apex, which is much more strongly incurved than in *E. Tschernyscheffi*, the larger and broader area, the deltidial fissure of which communicated with the truncated termination of the apex, and the large number of sharply marked striæ of growth, which are arranged parallel to the front-margin in zig-zag shaped lines.

There is no essential difference between the Sicilian and Himalayan specimens. Having compared a typical example of *Enteletes Waageni* from the "calcare grossolano" of Palazzo Adriano with my two dorsal valves from Chitichun No. I, the result was that I could perceive no difference in the shape of the umbonal regions, area and striation. To this similarity I have alluded in my memoir (l. c., p. 68), when stating *E. Tschernyscheffi* to be "very similar if not actually identical with a yet undescribed species from the permian rocks of Sicily, which the palæontological museum of the Vienna University had quite recently been able to acquire."

### ENTELETES SUBÆQUIVALVIS, Gemmellaro, Pl. I, fig. 8.

1899. *Enteletes subæquivalvis*, Gemmellaro. La fauna dei calcari con Fusulina della Valle del F. Sosio, Fasc. IV, Pte. I, p. 276, Taf. XXVIII, figs. 25—32.

I am acquainted with but a single though perfectly well preserved example of this species from the materials collected by Walker in the permian limestone of Chitichun No. I.

From *Enteletes Tschernyscheffi* my specimen is distinguished by its smaller size, more compressed shape, and by a different character of the radiating ribs, which are restricted to the anterior portion of the two valves.

The two valves do not differ remarkably in their dimensions. The ventral valve is comparatively flat, with a small and pointed apex, which is slightly bent over. The large, reclining area is cut open in the middle by a comparatively large triangular fissure.

The dorsal valve does not surpass the opposite one greatly in size, but is more strongly vaulted. Especially its apex is more strongly incurved and is provided with only a very small area.

Both valves are entirely smooth for a little less than half their extent from the apex. Then a broad median sinus begins to appear in the ventral valve. This sinus is followed on each side by three low and rounded folds. The intercostal furrows are broader than the ribs. In the dorsal valve seven ribs are observed, the median fold, which corresponds to the sinus in the opposite valve, being the largest. Although the ribs are rounded above, the front-margin exhibits an angular, zig-zag outline.

My specimen being a cast without any trace of the shelly substance, the radial striation of the latter, which has been noticed by Gemmellaro in his Sicilian examples of *E. subæquivalvis*, cannot be observed. In the surface of the cast numerous indistinct zig-zag striæ of growth are, however, visible.

The three septa in the ventral valve can be distinctly discerned.

The measurements of this specimen are as follows:—

| | | |
|---|---|---|
| Entire length of the shell | 13·5 | mm. |
| Length of the smaller valve | 13 | ,, |
| Entire breadth of the shell | 15 | ,, |
| Length of the hinge-line | 7 | ,, |
| Thickness of both valves | 10 | ,, |
| Height of the area of the smaller valve | 1 | ,, |

This species appears to be easily distinguishable from both *Enteletes Tschernyscheffi* and *E. Waageni* by the above-mentioned characters. Its specific claims, in view of its close relationship to congeneric species from the permian rocks of Sicily, may, however, require further consideration, when more ample material shall have been obtained. *E. Haugi*, Gemmellaro (l. c., p. 273, Taf. XXVIII, figs. 33—39), and *E. subæquivalvis* are so nearly allied, that I should be disposed to consider these two so-called species as identical, if a gradation from the low median fold in the dorsal valve of *E. subæquivalvis* to the sharp, prominent rib in *E. Haugi* could be proved, this being the only good character of distinction between them.

### TEREBRATULOIDEA cf. DEPRESSA, Waagen, Pl. II, fig. 19.

1883. *Terebratuloidea depressa*, Waagen, Salt Range Fossils, Palæont. Indica, ser. XIII, vol. I, Productus Limestone Foss., p. 419, Pl. XXXIII, figs. 6—8.

The identification of a single incomplete specimen with this Salt Range species is rather doubtful and can be admitted only with great reserve. The external features of my specimen undoubtedly favour this identification, but are not sufficient to warrant it with any certainty.

The most striking character of the genus or sub-genus *Terebratuloidea*, Waagen, is the presence of a large apical foramen, truncating the beak of the ventral valve. Waagen makes this a feature of primary importance. In my specimen the presence of this character cannot, unfortunately, be ascertained, as the beak of the ventral valve has been partly broken off. There is some probability in favour of a suggestion that the outlines of the fragment correspond to the traces of a large apical foramen, but I could not venture to assert this suggestion positively on such insufficient materials. I am consequently uncertain as to the generic position of my specimen, some of the species of the American upper carboniferous faunæ, which belong to the sub-genus *Pugnax*, having been proved by Hall and Clarke to differ from *Terebratuloidea* only by their foramen being normally concealed at maturity.

It is consequently with great reserve that I place this specimen provisionally with *Terebratuloidea*, on the strength of its external resemblance to *T. depressa* from the middle Productus limestone of the Salt Range.

The shell is transversely oval, considerably wider than long, with very flat and depressed valves. The high median fold in the dorsal valve is ornamented with five angular ribs, which are highest in the frontal region and gradually disappear before reaching the apex. In the corresponding sinus of the ventral valve there are four strong angular ribs. There are four ribs on each of the lateral parts in both valves. The front-line is sharp, not truncated, as in *T. Davidsoni*, Waagen.

The number of ribs in the median fold and sinus of my specimen is slightly larger than in Waagen's type-specimen of *T. depressa*, but smaller than the number of ribs in those varieties of *Rhynchonella pleurodon*, Phill., which in their general shape and sculpture agree most closely with the present example. A variety of this kind is the type illustrated on Pl. XXIII, figs. 4 and 5, of Davidson's Monograph of British Carboniferous Brachiopoda, in which, however, the mesial fold and sinus far exceed the lateral parts in width, and are ornamented with six and five angular ribs respectively.

The measurements of this specimen are as follows:—

| | | | |
|---|---|---|---|
| Entire length of the shell . . . . . . . | ca. | 15 | mm. |
| Length of the dorsal valve . . . . . . | „ | 13 | „ |
| Entire breadth of the shell . . . . . . . | „ | 22 | „ |
| Thickness of both valves . . . . . . . | „ | 8·5 | „ |

*Terebratuloidea depressa*, to which species the present specimen may be referred with some probability, has been quoted by Waagen from the upper region of the middle Productus limestone. This is the division of the Salt Range Productus limestone which has the greatest number of species in common with the fauna of the permian limestone crag of Chitichun No. I.

### UNCINULUS JABIENSIS, Waagen, Pl. II, fig. 5.

1883. *Uncinulus jabiensis*, Waagen. Salt Range Fossils, Palæont. Indica, ser. XIII, vol. I, Productus Limestone Foss., p. 427, Pl. XXXIV, fig. 2.

1900. *Uncinulus jabiensis*, G. v. Arthaber. Über das Palæozoicum in Hocharmenien und Persien, Beiträge zur Geol. u. Palæont. Oesterr.-Ungarns, etc., XII, p. 282, Taf. XXII, figs. 14, 15.

Among the group of subcuboidal *Rhynchonellidæ*, for which the term *Uncinulus*, proposed by Bayle in 1878, has been adopted by Waagen and Oehlert, three species have been distinguished in the Productus limestone of the Salt Range by Waagen. For those species the denominations *U. Theobaldi*, *U. jabiensis* and *U. posterus* have been introduced.

Rothpletz in his memoir on the permian fauna of Timor considers *U. Theobaldi* and *U. jabiensis* as synonyms and unites them with *U. timorensis* Beyrich. L. v. Lóczy (Wissenschaftliche Ergebnisse der Reise des Grafen Béla Széchenyi in Ostasien III, Bd. 4, Abth. p. 112) went even further, placing all the species distinguished by Waagen among the varieties of *U. timorensis*. In my memoir on the fauna of Chitichun No. I (p. 69) I have been led to suppose that *U. timorensis* and *U. Theobaldi* ought at least no longer to be maintained as separate species, as they do not differ by constant characters, but that *U. jabiensis* might be retained as a distinct species. G. v. Arthaber agrees with me in this view, while stating that his specimens of *U. jabiensis* from Djulfa are less transversely oval, flatter and more densely ribbed than *U. timorensis*.

I feel satisfied that my interpretation of these species has been proved correct by the discovery of a specimen of *U. jabiensis* among the materials collected by Walker in the permian limestone crag of Chitichun No. I.

Among my numerous specimens of *U. timorensis* from that locality, I have traced the passage from Beyrich's type, with a flat or nearly impressed ventral valve, a smooth apical region and a median fold and sinus, very broad in comparison with the lateral parts, through *U. Theobaldi*, in which the lateral parts and mesial sinus, or fold, are of nearly equal width, the ventral valve is flatly arched, not impressed, and the ribs cover nearly half the extent of the valves, to *U. posterus*, in which the ribs extend into the apical region. Whereas among my materials, the typical forms of both *U. timorensis* and *U. Theobaldi* were found to be linked together by a series of intermediate types, uniting one or more of the characters which Waagen had believed to be of specific importance, I had never seen a specimen with the triangular, or rather pentagonal, outlines, by which *U. jabiensis* is characterized according to Waagen's description and figures. It was only subsequently that Dr. Walker discovered a fine example of this type which differs so remarkably from all the rest of the specimens that I do not hesitate to retain it as a distinct species.

My specimen is of a pentagonal shape, exactly as long as it is broad, with strongly compressed valves, the ornamentation of which is restricted to the margins. The two valves are of unequal thickness. The ventral valve is perfectly flat, though not impressed, the dorsal valve slightly arched, but truncated at the front. The sinus does not extend above the middle of the length of the ventral valve. It is shallow and prolonged into a rectangular lobe, which is limited on each side by low, steeply inclined margins. Thus two elevated lateral lobes are produced in the dorsal valve, which correspond to the rectangular mesial lobe in the ventral valve. The small deltidial plate of the apex is distinctly visible. The hinge-line is strongly curved and not limited above by a false area.

Both valves are smooth in their apical and ventral portions. The ribs are confined to the vicinity of the margins. They are strongest on the surface of the lateral lobes. Within the sinus seven ribs are counted, the majority of which are provided with delicate furrows on their tops.

The dimensions of this specimen are as follows :—

| | |
|---|---|
| Entire length of the shell . . . . . . . | 12·5 mm. |
| Length of the dorsal valve . . . . . . . | 11·5 „ |
| Entire breadth of the shell . . . . . . . | 12·5 „ |
| Thickness of both valves . . . . . . . | 6·5 „ |

There can be no doubt, I think, as to the correctness of the identification of this specimen with *U. jabiensis*. The specific value of the features by which it is distinguished from *U. timorensis* scarcely requires further confirmation. I know of no intermediate shape by which it might be connected with Beyrich's species.

*Uncinulus jabiensis* has been quoted from the upper division of the Productus limestone by Waagen, and from the permian Otoceras beds of Djulfa by G. v. Arthaber.

*Remarks.*—Gemmellaro in his memoir on the permian fauna of the Fusulina limestone of Sicily (Fasc. IV, pt. I, Palermo, 1899) published the descriptions of three new species of *Uncinulus*, namely, *U. velifer* (p. 259, Tav. XXVI, figs. 51—57), *U. Amor* (p. 260, Tav. XXVI, figs. 58—61), *U. siculus* [p. 261, Tav. XXVI, figs. 64—68, (?) 62, 63]. It must, however, remain undecided, whether they are in reality more than varieties or simple modifications of *U. timorensis* and *U. jabiensis*. It has been urged by Gemmellaro that *U. velifer* is easily distinguishable from all other congeneric species by the presence of longer ribs which reach from the apical region to the periphery of the shell. This view is by no means correct. The intimate connection between the typical *U. timorensis*, with a smooth cardinal region, and *U. velifer* and *U. posterus*, with their surface almost entirely covered with ribs, has been demonstrated by the study of a very considerable number of specimens from Chitichun No. I. (more than sixty), which indubitably, by gradation, assume the characteristic ornamentation of *U. velifer*. A glance at Pl. X, fig. 8, of my memoir on the fauna of Chitichun No. I (pt. 3 of this volume) will at once show the close resemblance between this figure and Gemmellaro's illustration of *U. velifer* (especially figs. 55 and 57). No doubt, if certain typical, or what might be considered typical, shapes of *U. timorensis* and *U. velifer* are selected, the more distinct ornamentation of the apical region in the latter species might be considered as a specific peculiarity, but I do not admit this difference to be a valid ground for separating them specifically, or of sufficient value to counterbalance the great resemblance they present in all their dispositions and characters.

Nevertheless I prefer, for the present at least, to abstain from uniting the two under the single denomination of the Asiatic shell, until varieties with a smooth apical region have been discovered in the permian rocks of Sicily. In this respect I follow Schellwien, who has retained the name of *U. velifer* for his specimens from the permocarboniferous strata of the Eastern Alps.

A similar difference of opinion may be expressed with reference to the specific claims of *U. siculus* and *U. Amor*. The differences between *U. Amor* and *U. jabiensis* consist in the smaller size and more globose shape of the former species. The specimen represented on Pl. XXVI, fig. 62, of Gemmellaro's memoir, which that author doubtfully refers to *U. siculus*, appears still more similar to *U. jabiensis*. With the latter species Gemmellaro's illustration agrees in the pentagonal outlines and in the character of the sinus and ornamentation. According to the measurements given by Gemmellaro, the type-specimen of this illustration ought to be transversely oval, a length of 13 mm. corresponding to a breadth of 19 mm., and to a thickness of 9 mm. But if these measurements were supposed to be correct, the drawing would be entirely misleading, representing, as it does, a shell 15 mm. in length, 18 mm. in width, and 11 mm. in thickness.

Not having had the opportunity of examining any specimens of *Uncinulus* from Sicily, it would be difficult for me to decide whether the example, which has been referred by Gemmellaro with some reserve to *U. siculus*, ought in reality to be identified with *U. jabiensis*. There is little doubt, however, as to the intimate resemblance existing between certain examples of *Uncinulus* from Sicily and Waagen's Indian species.

### CAMAROPHORIA PURDONI var. GIGANTEA, Diener, Pl. II, fig. 18.

1897. *Camarophoria gigantea*, Diener. The permocarb. fauna of Chitichun No. I. Palaeont. Ind., ser. XV, Himalayan Foss., vol. I, pt. 3, p. 72, pl. XII, figs. 5, 7, 10.

In my description of *Camarophoria gigantea*, I did not omit to refer to the several difficulties in the way of a satisfactory determination of its specific claims with regard to its very close relationship to *C. Purdoni*, Dav. As appreciable differences between the two species, the remarkable size and the larger number of ribs in *C. gigantea* were noticed, and special stress was laid on the fact that no intermediate types between the two forms were known to me.

Having examined and compared a large number of specimens of *C. Purdoni* and *C. gigantea*, which were collected in 1899 by Walker, I am now very much afraid that they will have to be merged into a single species. The result of my examination was, that in different examples of *Camarophoria Purdoni* and *C. gigantea* the number of ribs is so variable, that it can no longer be considered as constituting an appreciable difference between them. I must admit that, if we cast a glance at the specimen chosen for illustration (Pl. II, fig. 18), which in its size and outlines closely agrees with *C. Purdoni*, the number of ribs (24 in the dorsal valve) is the same as in many typical examples of *C. gigantea*.

*Camarophoria Purdoni*, Dav., it is true, does not appear to have attained the large proportions of a full-grown *C. gigantea*, but size, as has been justly remarked by Prof. Davidson, cannot be made use of as a distinguishing character between species which otherwise closely resemble each other.

I consequently prefer to admit but one species, retaining *C. gigantea* as a variety of *C. Purdoni*.

### CAMAROPHORIA cf. SEMIPLICATA, Gemmellaro, Pl. II, fig. 7.

1899. *Camarophoria semiplicata*, Gemmellaro. La Fauna dei calcari con Fusulina della valle del F. Sosio, Fasc. IV., Pte. I, p. 267, Tav. XXVII, figs. 30—42.
1899. *C. solitaria*, Gemmellaro. *Ibidem*, p. 269, Tav. XXVII, figs. 26—29.

The identification of a single specimen with Gemmellaro's species is not perfectly sure, as I had no examples from Sicily available for comparison. Thus my determination is based on Gemmellaro's figures and description only, a rather unsafe ground, when one has to deal with a group so difficult as the carboniferous and permian *Rhynchonellidæ*.

My specimen is of small size, strongly asymmetrical, elongated, provided with a very strongly vaulted dorsal valve, and with a distinctly developed sinus and mesial fold.

The ventral valve is regularly and moderately vaulted. Its sinus takes rise at about half the length of the shell and is slightly produced at the front. The dorsal valve is much more strongly inflated, and its mesial fold is considerably elevated above the steeply inclined lateral parts. The anterior portion is smooth in both valves.

The ribs begin at about half the length of the shell and extend to the margin as very prominent, sharp, radiating costæ. Of these, three occupy the mesial fold and two the corresponding sinus, thus producing a triplicate frontal line. On the lateral parts of each valve there are two ribs on either side, the internal one being the more prominent.

The beak of the ventral valve having been partly broken off, the dental plates are exposed within the apex. The beak is rather thick, and smooth spaces extend on each side forming an indistinct false area. Not the slightest trace of marginal expansions has been noticed.

The measurements of this specimen are as follows :—

| | |
|---|---|
| Entire length of the shell . . . . . . . | 11 mm. |
| Length of the dorsal valve . . . . . . . . | 9 „ |
| Entire breadth of the shell . . . . . . . . | 9 „ |
| Thickness of both valves . . . . . . . . | 8 „ |

Gemmellaro, while admitting the very close relationship of *Camarophoria semiplicata* with *C. Schlotheimi*, v. Buch, considers them to be distinguished by the following features. The apical angle is more acute in *C. semiplicata*, and the beak more distinctly pointed. The greatest breadth of the shell is never situated in the anterior portion, as in *C. Schlotheimi*. The dorsal fold is nearly always asymmetrical and ornamented with more prominent and diverging ribs. With the exception of the pointed beak, which has been partly broken off, all these distinguishing characters of *C. semiplicata* are clearly represented in my specimen. The more or less marked presence of a false area is scarcely a character of importance, as it is chiefly a matter of convenience whether we term the smooth spaces on both sides of the apex in *Camarophoria* a sort of false area or not.

Although I cannot positively assert that the present specimen and Prof. Gemmellaro's Sicilian examples really belong to the same species, they are certainly very nearly allied to one another. This remark applies with equal reason to *C. solitaria*, Gemmellaro, the specific claims of which do not appear to me to have been clearly established. I must confess, that I cannot see any difference of importance between my Himalayan example and the type-specimen of Gemmellaro's illustrations. The difference in the proportion of length to width between the two shells is not more pronounced than one is accustomed to meet with in other examples of Brachiopoda, which belong to the same species.

### CAMAROPHORIA GLOBULINA, Phillips, Pl. II, fig. 6.

1834. *Terebratula globulina*, Phillips. Encyclop. Met. Geology, vol. IV, Pl. III, fig. 3.
1846. *Camarophoria globulina*, King. Annals of Nat. Hist., vol. XVIII, p. 28.
1850. *Camarophoria globulina*, King. Monograph of the permian foss. of England. Transact. Palæontograph. Soc., vol. III, p. 120, Pl. VII, figs. 22—25.
1858. *Camarophoria globulina*, Davidson. Monograph of the British foss. Brachiopoda, pt. IV, p. 27, Pl. II, figs. 28—31.
1883. *Camarophoria globulina*, Waagen. Salt Range Foss. Palæont. Indica, ser. XIII, vol. I, Productus Limestone Foss., p. 443, Pl. XXX, figs. 13, 14.
1894. *Camarophoria globulina*, Netschajew. Die Fauna der permischen Ablagerungen des oestlichen Theiles des europæischen Russlands. Trudy of the Imper. University of Kasan, vol. XXVII, pt. 4, p. 152, Pl. V, fig. 13.
1900. *Camarophoria globulina*, Schellwien. Die Fauna der Trogkofelschichten in den Karnischen Alpen und den Karawanken, Abhandl. Geol. Reichs-Anst., XVI, p. 98, Taf. XIV, figs. 5, 6.

*Vide* also the synonyms for *C. rhomboidea*, Phillips, (Geology of Yorkshire, vol. II, p. 222, Pl. XII, figs. 18—20).

I cannot but consider the little shells, one of which has been figured on Pl. II, all identical with Phillips' well-known European species.

My type-specimen resembles more closely the British examples, which have been figured by King and Davidson, than the Indian ones from Waagen's Salt Range collections. Among the specimens of *Camarophoria*, figured by Davidson, there is none to which the present specimen agrees more closely than the example of *C. rhomboidea* which has been illustrated on Pl. LIV, fig. 20, of Davidson's monograph.

It is moderately large, of globular shape, exactly as wide as long, and provided with strongly inflated valves. The small incurved beak has been partly broken off in all my specimens, thus exhibiting the dental plates. The dorsal valve is a little more strongly vaulted than the ventral. In both valves distinct sculpture is restricted to the marginal region. The shallow and slightly produced sinus is divided by a mesial fold, which causes the front line to ascend in a biplicate wave.

On each of the lateral parts two folds are developed.

There are no traces of marginal expansions observable. In the dorsal valve the presence of a median septum, which occupies one-third of the entire length of the shell, is distinctly noticed.

The measurements of this specimen are as follows :—

| | |
|---|---|
| Entire length of the shell | 12 mm. |
| Length of the dorsal valve | 10 ,, |
| Entire breadth of the shell | 12 ,, |
| Thickness of both valves | 8 ,, |

Much difference of opinion exists with regard to the identity of *Camarophoria globulina* and *C. rhomboidea*. Notwithstanding L. de Koninck's and Waagen's statements to the contrary, I am disposed to follow the view of Prof. Davidson and Schellwien, who unite the shells from the mountain limestone and from the permian system under a single specific denomination. Their resemblance is, indeed, so great, that the difference, which, according to Waagen, is constituted by the shape of their respective ventral valves, can barely be considered as of specific importance.

### NOTOTHYRIS TRIPLICATA, Diener, Pl. II, figs. 11, 12.

1897. *Nototkyris triplicata*, Diener. The permocarbon. fauna of Chitichun No. I. Palæont. Indica, ser. XV, Himalayan Foss., vol. I, pt. 3, p. 78, Pl. XIII, figs. 1, 2.

When publishing my description and figures of this interesting species, I expressed a regret that all my efforts had proved ineffectual in making out its internal characters. Thus it was only on the analogy of its external shape, that it could be placed in Waagen's genus *Nototkyris*. Among the materials which since then have been collected by Walker, *N. triplicata* is very richly represented. After having sacrificed a large number of specimens for the investigation of their internal characters, I have at last succeeded in making visible the brachial apparatus of the dorsal valve.

Its arrangement is identical with that noticed by Schellwien in Alpine and Russian representatives of the genus *Nototkyris*. It completely agrees with the excellent illustration of a transverse section of *Nototkyris exilis*, Gemmellaro, which has been figured by Schellwien on Pl. XVI, fig. 16 A, of his memoir on the permocarboniferous fauna of the Eastern Alps (Abhandl. K. K. Geol. Reichs-Anst., XVI, Bd., p. 102). The section exhibits the loop of the crura supporting a median longitudinal ridge, a peculiarity of the sub-family of *Centronellinæ*. This median ridge extends both towards the apical region and front-margin. Among the materials from Chitichun No. I, specimens of Brachiopoda, in which the internal characters can be observed, are quite an exception, the overwhelming majority of casts being filled up completely with so spathic a matrix that polished sections are of very little use.

The most important specific character by which *Nototkyris triplicata* is distinguished from other congeneric forms is its peculiar ornamentation, three high and sharp frontal folds being developed in the middle portion of the ventral valve. Among the material collected by Walker, examples have, however, been found, in which the two folds separating the frontal and lateral parts are but very little more strongly developed than the remaining folds. These specimens, one of which has been illustrated on Pl. II, fig. 11, show a certain affinity to *N. Warthi*, Waagen, but are always distinguished from that species by the presence of a mesial rib in the ventral valve, whereas in *N. Warthi* the mesial portion of the ventral valve is occupied by an intercostal depression.

The identity of *Notothyris*, Waagen, and *Rostranteris*, Gemmellaro, has been completely proved by the investigations of Schellwien.

Among Walker's fossil materials from Chitichun No. I, the genus *Notothyris* is rather richly represented. There are altogether four species, which may be safely assigned to that genus, two of them being identical with Sicilian forms.

### NOTOTHYRIS MEDITERRANEA, Gemmellaro, Pl. II, figs. 14, 15.

1899. *Rostranteris mediterraneum*, Gemmellaro. La fauna dei calcari con Fusulina della Valle del F. Sosio, Fasc. IV, Pte. I, p. 244, Tav. XXVI, figs. 1—6 ; XXVII, fig. 59.

1899. *Rostranteris inflatum*, Gemmellaro. *Ibid.*, p. 245, Pl. XXV, figs. 42—45 ; XXX, fig. 43.

The identification of four specimens from the permian limestone of Chitichun No. I with Gemmellaro's Sicilian species does not seem in any way doubtful, as far as one can judge from the excellent illustrations given by the Italian author.

The general outline of my specimens is elongately oval, with a slightly compressed posterior portion and a distinctly triplicate frontal wave. The two valves are unequally vaulted, the ventral valve being deeper than the dorsal. The ventral valve is strongly arched both in longitudinal and transverse directions. Its beak is large, prominent and truncated by an oval foramen. The triangular fissure is entirely concealed below the apex.

On the front-margin two strong folds of the ventral valve meet three corresponding folds of the dorsal valve in a W-shaped line. On the lateral parts of the ventral valve one more fold is noticed on each side. These lateral folds are very short and in one of my specimens only indistinctly developed. Gemmellaro does not mention the presence of lateral folds in his Sicilian examples, though they appear to be represented in two of his illustrations (Pl. XXVI, figs. 2 and 5). The posterior portion of the shell is perfectly smooth in both valves, the folds in the ventral valve taking rise at about half its length and those in the dorsal valve being still shorter.

The measurements of the two figured specimens are as follows :—

| | Fig. 14. | Fig. 15. |
|---|---|---|
| Entire length of the shell . . . . . . | 16·5 mm. | 10 mm. |
| Length of the dorsal valve . . . . . . | 14·5 „ | 8 „ |
| Entire breadth of the shell . . . . . . | 12·5 „ | 8 „ |
| Thickness of both valves . . . . . . | 10 „ | 6·5 „ |

*Number of specimens examined.*—4.

*Remarks.*—The importance of the elongately compressed shape of the anterior portion as a character of specific value is questionable. Gemmellaro regards it as a feature by which it may be distinguished from ***Rostranteris inflatum***. I am not, however, quite so certain as to the absolute value of this character in the forms under discussion, as in one of my Himalayan examples (fig. 15) the anterior portion of the ventral valve is decidedly more gibbous than in the Sicilian specimen illustrated on Pl. XXVI, fig. 5, of Gemmellaro's monograph, thus forming a passage from the typical *Rostranteris mediterraneum* to *R. inflatum*.

If the separation of the two species ought to be maintained, as has been advocated by Gemmellaro, the name *Rostranteris* (recte *Notothyris*) *inflatum* must be changed, this denomination having been assigned to a species of the Salt Range Productus limestone by Waagen (l. c., p. 384).

### NOTOTHYRIS EXILIS, Gemmellaro, Pl. II, fig. 16.

1899. *Rostranteris exile*, Gemmellaro. La fauna dei calcari con Fusulina della Valle del F. Sosio, Fasc. IV, Pte. I, p. 243, Pl. XXV, figs. 68—70; XXVII, fig. 60; XXX, fig. 42.

1900. *Notothyris exilis*, Schellwien. Die Fauna der Trogkofelschichten in den Karnischen Alpen und den Karawanken Abhandl. K. K. Geol. Reichs-Anst., XVI, p. 108, Taf. XV, figs. 13—17.

This species is distinguished from *Notothyris mediterranea* by its more slender and compressed shape, by the absence of a distinct sinus in the ventral valve, and by its short folds, which are restricted to the vicinity of the front-margin.

The single specimen among my Himalayan materials which can be attributed to *Notothyris exilis*, agrees very closely with Gemmellaro's type-specimens, with the single exception that its shape is a little less distinctly pyriform. In this character of its outline it agrees perfectly with the majority of the Alpine examples, which have been illustrated by Schellwien, exceeding them, however, considerably in its dimensions. Gemmellaro's largest type-specimen is also slightly inferior in size. The folds are strongly marked, though very short, especially so in the dorsal valve.

The measurements of this specimen are as follows:—

| | |
|---|---|
| Entire length of the shell . . . . . . . . . . | 13 mm. |
| Length of the dorsal valve . . . . . . . . . . | 11·5 " |
| Entire breadth of the shell . . . . . . . . . . | 9·5 " |
| Thickness of both valves . . . . . . . . . . | 7 " |

As has been stated by Schellwien, *Notothyris exilis* is more easily distinguished from its allies than all the other congeneric forms. There can consequently be but little doubt as to its being represented among the permian fauna of the limestone crag of Chitichun No. I.

### NOTOTHYRIS WALKERI, nov. sp., Pl. II, fig. 13.

I regret to say that the materials of this new species at my disposal are very scanty, only a single although perfectly preserved specimen being contained in

Walker's collections. I have discovered a very nearly allied form among A. v. Krafft's collections from an exotic block near Malla Johar in the Balchdhura region, the fauna of which will be described in the following chapter. By an examination of the present specimen, however, the characters of the new species have been fixed with sufficient clearness to justify its description under a separate designation.

This species is very easily distinguished from all other congeneric forms by its peculiar shape. The general outline of the shell is difficult to define. It is elongately oval as seen in the dorsal aspect, but almost semi-circular as seen in the lateral view. The two valves are of very unequal size. The dorsal valve is flat and not inflated, the ventral one very strongly vaulted in the longitudinal and still more so in the transverse direction. Its transverse section is considerably higher than broad, and helmet-shaped. A short distance in front of the apical region a three-edged termination of the mesial portion of the valve is distinctly marked. A sharp crest in which the lateral parts unite at an angle of 60 degrees, corresponds to the median line. A low secondary ridge or fold runs parallel to the median crest on each side. To these three folds only very small marginal indentations correspond in the front, which exhibits a pentagonal outline.

The beak is thick and large, strongly incurved and firmly appressed to the apex of the dorsal valve, so as to conceal entirely the triangular fissure of the ventral valve. It is truncated by a large, oval foramen.

The dorsal valve is nearly flat and entirely smooth.

Both valves are ornamented with numerous but delicate imbricating striæ of growth, which cover all parts of the shell, from the point at which the median crest-fold commences.

The measurements of my type-specimen are as follows:—

| | |
|---|---|
| Entire length of the shell . . . . . . . . . | 16·5 mm. |
| Length of the dorsal valve . . . . . . . . . | 14 ,, |
| Entire breadth of the shell . . . . . . . . . | 10 ,, |
| Thickness of both valves . . . . . . . . . | 12 ,, |

The general shape of this specimen is so singular and widely different from other congeneric species, that a special enumeration of its features of distinction appears barely necessary. The internal characters of the specimen being unknown to me, it is only on the analogy of its external shape that I place it in Waagen's genus *Notothyris*. The question whether it ought better be attributed to *Notothyris* or to *Hemiptychina* will be discussed in the description of a second species, very closely allied to the present one from A. v. Krafft's collections.

### HEMIPTYCHINA SUBLÆVIS, Waagen, Pl. II, fig. 3.

1882. *Hemiptychina sublævis,* Waagen. Salt Range Foss., Palæont. Indica, ser. XIII, vol. I, Productus Limestone Foss., p. 364, Pl. XXVII, figs. 1—3.

Walker's specimens from Chitichun No. I are provided with the same ovoid outlines, the strongly inflated valves and the vaulted, barely indented front-line, by which the specimens from the Salt Range Productus limestone are distinguished from their allies.

My specimens are rather variable in shape and proportions. Among forms of an elongately oval shape one specimen is met with in which the length and breadth of the shell are almost equal. In all my specimens the vaulted frontal line exhibits no trace of marginal indentations.

I have not been able to discover the presence of dental plates in the ventral valve and consequently believe my identification of the specimens in question with *Hemiptychina* justified.

The measurements of the figured specimen are as follows:—

| | |
|---|---|
| Entire length of the shell . . . . . . . . . | 17·5 mm. |
| Length of the dorsal valve . . . . . . . . . | 15 " |
| Entire breadth of the shell . . . . . . . . . | 13 " |
| Thickness of both valves . . . . . . . . . | 10 " |

*Number of specimens examined.*—4.

*Remarks.*—*Hemiptychina sublævis* is quoted by Waagen from the lower Productus limestone. He admits, however, the recurrence of "specimens very similar to the present species" in higher beds of the Productus limestone series of the Salt Range. This fact is rather unfavourable to his theory, that all the species of *Hemiptychina* in the Productus limestone form a developmental series, which is characterized by the successive apparition of folds on the shell. In this opinion I am afraid Prof. Waagen has been mistaken. The presence of forms with a perfectly smooth front-margin together with strongly plicated ones, such as *Hemiptychina inflata*, Waagen, in the Chitichun limestone is a very strong argument to the contrary.

### DIELASMA ELONGATUM, Schlotheim, Pl. I, fig. 9; Pl. II, fig. 4.

1816. *Terebratulites elongatus, Terebratulites complanatus* et *Terebratulites latus*, Schlotheim. Denkschr. Kgl. bayrisch. Akad. d. Wissensch. Muenchen, vol. VI, p. 27, Pl. VII, figs. 7, 9, 12—14.
1850. *Epithyris elongata*, King. A monograph of the permian fossils of England. Transact. Palæontograph. Soc., vol. III, p. 147, Pl. VI, figs. 30—45.
1858. *Terebratula elongata*, Davidson. British Fossil Brachiopoda, vol. II, p. 9, Pl. I, figs. 5, 7, 12—14, 18—22.
1861. *Terebratula elongata*, Geinitz. Die Dyas, p. 82, Taf. XV, figs. 14—28.
1870. *Terebratula elongata*, Quenstedt. Petrefactenkunde Deutschlands, Brachiopoden, p. 425, Taf. L, figs. 104—116.
1882. *Dielasma elongatum*, Waagen. Salt Range Fossils. Palæont. Indica, ser. XIII, vol. I, Productus Limestone Fossils, p. 342, Pl. XXV, fig. 10.
1894. *Dielasma elongata*, Netschajew. Die Fauna der permischen Ablagerungen des oestlichen Theiles des europæischen Russlands. Trudy of the Imper. University of Kasan, vol. XXVII, No. 4, p. 185, Pl. V, fig. 16.

The preceding list of synonyms might easily have been enlarged considerably, but the quotations given with reference to the present species are sufficient to prove that it is the common European *Dielasma elongatum* from the Zechstein, with which my specimens, I believe, must be identified.

The shells referable to *D. elongatum* are rather variable in size and shape. Two varieties can be distinguished among them. Types of each variety have been chosen for illustrations.

The first type, which is represented by the example illustrated on Plate II, fig. 4, is of small size and agrees in all its characters with the variety from the dolomites of the middle Zechstein of Pœssneck in Saxony. I am at a loss to detect any difference between my Himalayan specimen and those which have been figured by Geinitz (especially Pl. XV, fig. 14). Nor could I perceive the smallest distinguishing features after comparison with many specimens of that shell from Pœssneck, which belong to the collections of the Palæontological Museum of the Vienna University. My figured Himalayan example resembles this variety from Pœssneck most closely, both in its average size, its flat shape, which thins out quite gradually towards the front, and in its distinctly attenuated apical region. In its external characters it also very closely resembles *Hemiptychina pseudoelongata*, Schellwien (Abhandl. K. K. Geol. Reichs-Anst., XVI, Bd., p. 107. Taf. XV, figs. 27—29), especially the specimen illustrated on Plate XV, fig. 28, from which, however, it differs by the presence of very markedly developed dental plates.

The second type is represented by the specimen illustrated on Plate I, fig. 9. It somewhat resembles the example from the middle Zechstein of Pœssneck, which has been illustrated by Geinitz on Plate XV, fig. 25, or still more closely the British specimens of the narrow variety figured by King on Plate VI, figs. 31, 35 and 39 of his monograph.

Whereas the typical or normal forms of *D. elongatum* are widest near the middle, in this variety the greatest breadth is situated in the anterior portion of the shell. The shell is very flat in front and provided with a sharp anterior margin. The apical region is attenuated, the ventral valve evenly curved in the transverse direction and without any trace of a mesial sinus. In the last-mentioned character my type differs from the British types of *D. elongatum*, in which a gradually depressed or shallow sinus is always present, although it becomes hardly perceptible in certain middle-aged and young shells. It agrees, however, in this respect with the above-quoted example from Pœssneck and with Waagen's specimens from the Productus limestone, in which "a median depression extending from near the beak to the frontal region and corresponding to the bend in the frontal line, is totally absent."

The measurements of these two type-specimens are as follows:—

| | Pl. I, fig. 9. | Pl. II, fig. 4. |
|---|---|---|
| Entire length of the shell . . . . | 25·5 mm. | 14·5 mm. |
| Length of the dorsal valve . . . . | 23 ,, | 13 ,, |
| Entire breadth of the shell . . . . | 16·5 ,, | 11 ,, |
| Thickness of both valves . . . . | 11 ,, | 6·5 ,, |

*Remarks.*—Although *Dielasma elongatum* is one of the chief leading fossils of the permian Zechstein in Western Europe, it is certainly not restricted to beds of permian age only. It only needs a glance at the long list of Russian localities, from which it has been quoted by Netschajew, to convince one of the large vertical distribution of this species. My friend Prof. Tschernyschew informs me that *D. elongatum* is certainly represented among his materials from the Uralian Schwagerina limestone of upper carboniferous age.

My opinion is that both Waagen and L. de Koninck have greatly overrated the stratigraphical value of a very narrow interpretation of species among the sub-genera of *Terebratulidæ*, such as *Hemiptychina*, *Dielasmina* and *Dielasma*, and that after all Davidson was entirely justified in admitting a recurrence of the majority of forms of *Dielasma* in the carboniferous and permian systems.

### DIELASMA sp. ind. aff. HASTÆFORME, de Koninck, Pl. II, fig. 1.

Among the large number of species of *Dielasma* which have been proposed by L. de Koninck some are distinguishable with so great difficulty and only by differences of such very small importance, that I have not been able to arrive at a decided opinion as to the affinities of my Himalayan shells. Not wishing to burden nomenclature with a new name, and mindful of the very small stratigraphical value of *Dielasma*, I have considered it best to refer my examples provisionally to the carboniferous species, which in its general characters it most nearly resembles.

My shells are of an elongately oval, obscurely pentagonal outline, and of large size. The greatest breadth is situated a little in front of the middle of the length. Both valves are regularly curved, but the dorsal one is somewhat less strongly vaulted. The beak is moderately produced, but slightly incurved, and truncated by an oval foramen, which slopes obliquely forwards. It is appressed to the apex of the dorsal valve, so as to conceal the deltidium entirely. The lateral portions of the beak are comparatively small and bordered by indistinct ridges. No trace of a mesial sinus is noticed in the ventral valves of any of my specimens. The frontal region is less distinctly truncated than in L. de Koninck's type-specimens of *Dielasma hastæforme*, de Kon. (Faune du calcaire carbonifère de la Belgique, Annales du Musée d'histoire naturelle de Belgique, Bruxelles, 1887, T. XIV, pt. VI, p. 19, Pl. I, figs. 36, 37, Pl. II, figs. 10—25), from the mountain limestone of Belgium. L. de Koninck describes the frontal margin of the latter as forming a horizontal line for some distance. This is not the case in my Himalayan shells, but the front is very slightly curved anteriorly, recalling in this respect the example of *Dielasma hastatum* var. *ficus*, M'Coy, which has been illustrated by Davidson on Pl. I, fig. 13, of his monograph on the British carboniferous Brachiopoda. From this type my specimens, however, differ by their more distinctly oval outline and by their smaller apices.

The measurements of the figured specimen are as follows :—

| | | |
|---|---|---|
| Entire length of the shell . . . . . . . . . | 39 | mm. |
| Length of the dorsal valve . . . . . . . . . | 36·5 | „ |
| Entire breadth of the shell . . . . . . . . . | 27 | „ |
| Thickness of both valves . . . . . . . . . | 16 | „ |

*Number of specimens examined.*—3.

*Remarks.*—My Himalayan species recalls *Dielasma hastæforme*, de Kon., from the mountain limestone of Belgium, without, however, being absolutely identical with it. If I were inclined to follow L. de Koninck's interpretation of species in *Dielasma*, I should probably be obliged to introduce a new name for my Chitichun species, as it is distinguished from all other congeneric forms by a few subordinate details, to which, in my opinion, a varietal importance only ought to be accorded.

### DIELASMA PLICA, Kutorga, Pl. II, fig. 2.

1842. *Terebratula plica*, Kutorga. Verhandlungen Kais. russ. Mineral. Ges., p. 26, Taf. V, fig. 11.
1862. *Terebratula plica*, V. von. Mœller. Geological and Palæontological notes, etc. Gornaj Journal IV, p. 63, Pl. I, figs. 3—6.
1899. *Dielasma plica*, Frech. Lethæa palæozoica, II, Bd., Taf. 47c, fig. 5.
1900. *Dielasma sp. ind.* (?), Schellwien. Die Fauna der Trogkofelkalke in den Karnischen Alpen und den Karawanken. Abhandl. K. K. Geol. Reichs-Anst., XVI, p. 105, Taf. XV, figs. 18, 19.

This species belongs to a group of forms characterized by a strongly vaulted ventral valve and by a very flatly arched dorsal valve. *Terebratula bovidens*, Morton, from the coal-measures of North America is the prototype of this group, which in Eurasia is represented by *T. plica*, Kutorga. Both description and illustration of the type-specimen of the Russian form of Kutorga are so unsatisfactory, that I should certainly not have been able to identify my Himalayan shells, had not the beautiful plates accompanying Prof. Tschernyschew's monograph of the upper carboniferous Brachiopoda of the Ural rendered Kutorga's memoir almost superfluous. From all the Salt Range species which belong to the group of *Dielasma bovidens*, my Himalayan specimen is distinguished by the presence of a sharply impressed ventral sinus.

The general shape of my type-specimen is pyriform and strongly elongated. The greatest breadth is situated in the middle of the length of the shell. The ventral valve is strongly vaulted, especially so in the vicinity of the beak and of the front line. In the transverse direction it is more flatly arched. A deep impression extends all along the median line of this valve from the apical region to the front, where it corresponds to a small emargination.

The beak is short and thick, distinctly bent over and pierced behind its apex by a large foramen, corresponding in its position exactly to the foramen in *Dielasma bovidens*, Mort., and *D. truncatum*, Waag. From both sides of the foramen indistinct ridges extend down along the lateral parts of the beak for some distance, marking off a broad and tolerably well-defined false area.

The dorsal valve is very flatly arched in the longitudinal but strongly vaulted in the transverse direction. In the latter direction the profile of this valve is nearly semi-circular. Thus the line in which the two valves meet is rather strongly marked laterally. From near the apex a distinct, perfectly straight ridge or edge extends to the front and there corresponds to the sharp impression in the middle of the ventral valve. The presence of this ridge is not due to an accidental malformation of the specimen during the process of fossilisation, as might be supposed, but is a well-marked character of *Dielasma plica*, as may be seen from an examination of the Russian specimens which have been illustrated by Tschernyschew on Plate IV of his above-quoted monograph.

The substance of the shell, which has been partly preserved, exhibits under the lens a very closely arranged and delicate granulation.

Of the internal characters of the shell only two strongly developed dental plates of the ventral valve can be seen through the translucent matrix of the fossil.

The measurements of my specimen are as follows :—

| | |
|---|---|
| Entire length of the shell | 28 mm. |
| Length of the dorsal valve | 25 „ |
| Entire breadth of the shell | 17 „ |
| Thickness of both valves | 13·5 „ |

*Remarks.—Dielasma sp. ind.* from the permo-carboniferous rocks of Carniola is most probably identical with the present species, as has been suggested by Schellwien, whose opinion was based on the insufficient figures and descriptions of *Dielasma plica* given by Kutorga and Val. von Mœller. The illustrations of the Alpine examples agree very closely with those of *D. plica* given by Prof. Tschernyschew.

### RICHTHOFENIA (?), sp. ind., Pl. II, fig. 17.

The presence of the interesting genus *Richthofenia*, Kayser, in the permian limestone of Chitichun No. I can not as yet be asserted with full certainty. But among the materials collected by Walker a fragment has been discovered which probably belongs to the larger valve of a *Richthofenia*. In consideration of the interest which is attached to the presence of this genus in strata of anthracolithic age, I think myself justified in describing and illustrating the fragment, which, according to my opinion, might be referred to the large valve of a *Richthofenia*.

The external shape of my fragment is irregularly conical, the apical portion having been broken off completely. Its transverse section is transversely oval. The fragment is filled up entirely by a compact matrix, in which no trace of the original structure of the shell has been preserved. The surface of the fragment, however, partly exhibits the ornamentation found in typical representatives of the genus *Richthofenia*. It is rugose and covered with numerous irregular, concentric wrinkles, which bear a few prominent spines, resembling most nearly the spine-bearing tubercles in *Productus*.

I have not been able to notice a punctate shell-structure.

My fragment, though not sufficiently well preserved to allow of an exact determination, so strongly recalls *Richthofenia* in some of its external characters, that I cannot avoid referring it to that genus.

## ECHINODERMATA.

### POTERIOCRINUS (?), sp. ind. Pl. II, fig. 20.

The reference of certain fragments of stems in Walker's collections to the genus *Poteriocrinus* is purely provisional. All that I can say in favour of my determination is that the stems closely resemble forms which have been attributed to that genus by Waagen.

The stems are small, of moderate thickness, provided with a narrow canal of circular outline, and ornamented with numerous delicate, radiating furrows. They resemble most closely the fragments of stems which have been quoted from the permian Otoceras beds of Djulfa by G. v. Arthaber.

## ANTHOZOA.

### AMPLEXUS CORALLOIDES, Sow., var. ABICHI, Waagen et Wentzel, Pl. II, figs. 24—28.

1878. *Amplexus coralloides*, Abich. Eine Bergkalkfauna aus der Araxesenge bei Djulfa in Armenien, p. 84, Pl. XI, fig. 10, p. 85, Pl. X, fig. 12, Pl. XI, fig. 15 (*var. geniculata*).
1879. *Amplexus sp. ind.*, Val. v. Mœller. Neues Jahrb. f. Min., etc., p. 237.
1887. *Amplexus Abichi*, Waagen et Wentzel. Salt Range Foss. Palæont. Ind., ser. XIII, vol. I, Productus Limestone Foss., p. 903.
1897. *Amplexus sp. ind. aff. A. Abichi*, Diener. The permocarb. fauna of Chitichun No. I. Palæont. Indica, ser. XV, Himalayan Foss., vol. I, pt. 3, p. 83, Pl. XIII, fig. 7.
1900. *Amplexus Abichi*, G. v. Arthaber. Ueber das Palæozoicum von Hocharmenien und Persien. Beitræge zur Palæont. und Geologie Oesterr.-Ungarns, etc., XII, p. 286.
1901. *Amplexus cf. Abichi*, Enderle. Ueber eine anthracolithische Fauna von Balia Maaden in Kleinasien. *Ibidem*, XIII, p. 95, Taf. VIII, fig. 5.

In my memoir on the fauna of Chitichun No. I a few imperfect specimens of *Amplexus* have been compared to this species, their unsatisfactory state of preservation forbidding a specific determination. Among the materials collected by Walker there is a small number of better preserved coralla which I do not hesitate to identify with *Amplexus Abichi.*

The specific claims of *Amplexus Abichi* are very uncertain, notwithstanding the lengthened description given by Prof. Waagen. Val. von Mœller has strongly urged the advisability of maintaining Abich's Armenian species as a distinct form differing remarkably, according to his opinion, from *A. coralloides*, Sow. Dr. G. von Arthaber kindly furnished me with all the materials of *A. Abichi* from his own collections from the permian rocks of Djulfa. Having had the opportunity of studying the Armenian type of species, I must confess my inability to see any of those distinctive features which V. von Mœller so emphatically announces. Waagen did not fail to observe the very close resemblance of Abich's and Sowerby's species, and rightly considers their separation rather difficult. "The chief differences," he states, "consist in the septa being slightly longer and somewhat less numerous than in equal-sized specimens of *A. coralloides*; so that the present species can well be considered as different, but must at the same time probably be taken as a direct descendant from the lower carboniferous species."

With regard to this statement I would observe that the length of the septa in one of my Himalayan specimens entirely agrees with that of typical specimens of *Amplexus coralloides*. Nor is the number of the septa a constant character of difference. In Arthaber's specimens of the Armenian type of *A. Abichi* 26 to 28 septa correspond to a diameter of 18 mm. This number differs somewhat from that observed in my Himalayan examples, the septa numbering 28 to a diameter of 14 and 30 to a diameter of 16 mm. In this respect they are more similar to the type of *A. Abichi* described by Enderle from the anthracolithic rocks of Balia Maaden in Asia Minor. His specimens, which, having regard to the character of their epitheca, are undoubted examples of *A. Abichi*, are characterized by a larger number of septa, 30 septa corresponding to a diameter of 14 mm. and 34 to a diameter of 21 mm.

Rothpletz (Die Perm-Trias-und Juraformation auf Timor und Rotti, Palæontographica, 39 Bd., p. 70), who did not think the length and number of septa sufficiently defined for a specific distinction of *A. Abichi* and *A. coralloides*, distinguished the two species by the character of the epitheca, which, according to his opinion, in *A. coralloides* never has the remarkable longitudinal striation observed in *A. Abichi*. Enderle agrees with Rothpletz in overrating the importance of this character, which is not constant, as has been ascertained by the examination of my Himalayan specimens. Among them examples are not rare in which the longitudinal striation is as strongly marked as in the specimens figured by Abich and Enderle, but every passage or intermediate link will be found connecting them with the common shape of *A. coralloides*, exhibiting an epitheca which is covered by numerous wrinkles of growth only, but devoid of almost any longitudinal striæ.

In my opinion *Amplexus Abichi* and *A. coralloides* resemble one another so closely even in characters of minor importance, that, until better evidence to the contrary arises, I prefer to consider the Himalayan and Armenian types as varieties of the widespread carboniferous species only, leaving it to future observers to decide whether or not this is to be taken as a correct interpretation.

The largest specimens of *A. Abichi*, described by Abich, G. v. Arthaber and Enderle, had a maximum length of 75 to 80 mm. My Himalayan specimens probably attained an equal size, but I cannot give exact measurements, the largest individuals not having been preserved entire. Of the calix of the polyparium especially nothing is known to me.

A character in which the longitudinal section of one of my Himalayan specimens approaches *Amplexus Wischerianus*, Stuckenberg (Korallen und Bryozoen der Steinkohlenablagerungen des Ural und des Timan, Mém. Comité géol. de la Russie, St. Pétersbourg, vol. X, No. 3, p. 189, Pl. II, fig. 8), is the remarkable irregularity in the distance and shape of the tabulæ, some of which are not horizontal but slightly concave. This character, however, is much more strongly developed in the Russian species, which differs altogether from *A. Abichi* by the presence of very deep, circular constrictions in the polyparium.

### ZAPHRENTIS BEYRICHI, Rothpletz, Pl. II, fig. 21.

1865. *Zaphrentis sp. ind.* (?), Beyrich. Ueber eine Kohlenkalkfauna von Timor. Abhandl. Kgl. Akad. d. Wissensch, Berlin, 1864, p. 85, Taf. II, fig. 4.

1892. *Zaphrentis Beyrichi*, Rothpletz. Die Perm-Trias-und Juraformation auf Timor und Rotti. Palæontographica, 39 Bd., p. 69, Taf. XII, figs. 16, 21, 22, 26—29.

There are two specimens of the genus *Zaphrentis* in Walker's Himalayan collections from Chitichun No. I. They can be identified with great probability with *Zaphrentis Beyrichi* from the permian rocks of Timor.

The corallum is simple, elongately conical and slightly curved, with a tolerably thick epitheca on its outer surface. It shows a distinct longitudinal striation and numerous wrinkles of growth, which are, however, considerably lower than in *Amplexus Abichi*, Waag. et Wentzel. Rothpletz does not mention the presence of wrinkles encircling the corallum, although they are clearly represented in the figure given on Pl. XIII, fig. 21, of his memoir.

The fan-shaped arrangement of the longitudinal striæ, as described by the same author, cannot be clearly observed, as the surface of my type-specimen has been partly injured by weathering. The majority of longitudinal striæ seem to correspond to the inter-septal portions of the cell, but I do not think that this rule is without exception.

The figure representing my type-specimen does not give a clear idea of its external characters, as I have, unfortunately, been obliged to sacrifice the larger portion of the corallum in order to obtain sections of its internal structure.

No trace of the calix having been preserved in any of my specimens, their identification has been chiefly based on the similarity of the internal structure, as exhibited in transverse sections, with the figures given by Rothpletz.

In a cross-section of my type-specimen I find 13 septa, reaching almost to the centre and 15 septa, which are but slightly inferior in length to the former. In the space between two septa a very short septum is inserted. Thus 54 to 56 septa are counted altogether. The cardinal septum is very short, while the counter-septum reaches the centre. The two alar septa are laterally disposed, including a very obtuse angle of nearly 180 degrees.

Neither a central columella nor a vesicular tissue have been observed.

Rothpletz believes Beyrich's type-specimen of *Zaphrentis sp. ind.* (l. c., Pl. II, figs. 4 and 6), to be absolutely identical with the present species. Martin (Sammlungen des Geologischen Reichs-Museums in Leyden I. Beiträge zur Geologie Ostasiens und Australiens, p. 36), on the contrary, identifies it with a new species of *Amplexus*, for which the new name *A. Beyrichi* is introduced.

*Zaphrentis Beyrichi* has been quoted from the permian rocks of Timor by Rothpletz, and from the permo-carboniferous limestone of Young-tchang-fu in Yunnan by L. v. Lóczy (Wissenschaftliche Ergebnisse der Reise des Grafen Béla Szechényi in Ostasien, vol. III, pt. 4, p. 129).

### CLISIOPHYLLUM (?), sp. ind., Pl. II, fig. 22.

It is with considerable hesitation that I refer a single fragment to this genus. The identification is based on the character of the microscopic transverse section only.

The circular section, corresponding to a diameter of 15 mm., exhibits a thin epitheca and numerous (28 to 30) primary septa, which alternate regularly with short secondary septa. The cardinal septum is situated in a fossula, which is shorter than the majority of the primary septa. The septa do not reach the central columella.

It is not possible to distinguish in the transverse section whether the columella is provided with longitudinal furrows or not.

The presence of a vesicular tissue is limited to the peripheral zone of the polyparium.

### DIBUNOPHYLLUM (?), sp. ind., Pl. II, fig. 23.

The fragment of a single corallum is provisionally and with much hesitation referred to the genus ***Dibunophyllum***, Nicholson, on account of the remarkable characters of its transverse section.

The transverse section is of circular shape and exhibits a moderately thick epitheca. Twenty-six primary septa correspond to a diameter of 15 mm. With the exception of the cardinal septum, which is situated in a distinct fossula, all of them reach the central area. They alternate with short, secondary septa of irregular length.

A vesicular tissue is distinctly developed, but the dissepiments are not very abundant in the interseptal loculi. The central area is of an obscurely hexagonal shape, with a longer diameter of 4 mm. and a shorter of 2 mm. Although the structure of this central area cannot be made out clearly from my insufficient materials, I have been able to distinguish a principal central lamella, corresponding exactly to the median axis of the polyparium, as marked by the position of the cardinal and counter septa.

The corallum itself is of very small size, with cylindro-conical outlines. The epitheca is covered with sharp, longitudinal furrows and annular wrinkles of an irregular character. There is a distinct constriction marked in the upper portion of my specimen, which probably may have been produced by calicinal gemmation, as has been described in ***Dibunophyllum vermiculare*** by Stuckenberg (Mém. Comit. géol. St. Pétersbourg, vol. X, No. 3, p. 216).

The scarcity of specimens precluding the free use of the grindstone, I have not succeeded in arriving at a satisfactory determination either of this or of the preceding species, although there is some probability of the correctness of their generic identification.

### PLEROPHYLLUM (?), sp. ind.

1872. *Pentaphyllum*, L. de Koninck, Nouvelles recherches sur les animaux fossiles du terrain carbonifère de, la Belgique. Mém. Acad. Royale de Belgique, p. 58.
1890. *Plerophyllum*, Hinde, Notes on the palæontology of Western Australia, Geol. Magazine, Decade III, vol. VII, p. 195.

I am, unfortunately, unable to give an adequate figure of the Himalayan representatives of this remarkable genus. The most important feature, namely, the presence of five prominently developed septa, is only visible in specimens in which the central area of the corallum is not reached by the septa. But the only specimen in which this character had been noticed, was unfortunately sacrificed in a fruitless attempt to get better polished sections. I must therefore abstain from giving any detailed descriptions, but confine myself to the statement that among Walker's materials of *Anthozoa* the genus *Plerophyllum* is probably represented.

I prefer to accept the generic designation introduced by G. Hinde for a group of *Tetracoralla*, which belong to L. de Koninck's genus *Pentaphyllum*, a term pre-occupied for a genus of coleoptera in 1821. Typical species of *Plerophyllum* have been described from the mountain limestone of Belgium and Western Australia, and from the permian Otoceras beds of Djulfa in Armenia by Frech (Beiträge zur Palæontologie und Geologie Oesterr.-Ungarns, etc., Bd. XII, p. 286).

The fragmentary specimens, which I have placed in this genus, were of small size and conical shape, and provided externally with longitudinal furrows.

## FAUNISTIC RESULTS.

The examination of Dr. Walker's collections has resulted in some very important additions to our knowledge of the interesting fauna of the permian limestone crag of Chitiohun No. I. To 48 species, which were known to me in 1897, 28 more have been added, some of which are of the highest stratigraphical importance and admit of a much more exact correlation of the Chitichun fauna than did the palæontological data available in 1897.

According to the present state of our knowledge the fauna of the limestone crag of Chitichun No. I is composed of the following species:—

### *Crustacea.*

1. *Phillipsia Middlemissi*, Diener.
2. *Cheiropyge himalayensis*, Diener.

### *Cephalopoda.*

3. *Nautilus (Domatoceras) hunicus*, Diener.
4. *Xenaspis carbonaria*, Waag.
5. *Popanoceras (Stacheoceras) Trimurti*, Diener.
6 *Cyclolobus Walkeri*, Diener.

### *Gasteropoda.*

7. *Naticopsis*, sp. ind.

### *Lamellibranchiata.*

8. *Aviculopecten aff. jabiensi*, Waag.

### *Brachiopoda.*

9. *Productus cora*, d'Orb
10. " *semireticulatus*. Mart.
11. " *chitichunensis*, Diener.
12. " *cf. subcostatus*, Waag.
13. " *gratiosus*, Waag.
14. " *cancriniformis*, Tschernyschew.
15. " *Abichi*, Waag.
16. " *mongolicus*, Diener.
17. *Marginifera typica*, Waag.
18. *Aulosteges tibeticus*, Diener.
19. *Lyttonia nobilis*, Waag.
20. *Spiriferina octoplicata* var. *fastigata*, Schellw.
21. " *Margaritæ*, Gemmell.
22. *Spirifer fasciger*, Keys. (=*musakheylensis*, Dav.).
23. " *Wynnei*, Waag.
24. " *tibetanus*, Diener.
25. *Martinia cf. glabra*, Mart.
26. " *elegans*, Diener (=*Distefanoi*, Gemm.).
27. " *nucula*, Rothpletz.
28. " *semiplana*, Waag.
29. " *acutomarginalis*, Diener (=*Semiramis*, Gemm.).
30. " *contracta*, Meek et Worth.
31. *Reticularia cf. lineata*, Mart.
32. " *pulcherrima*, Gemm.
33. " *inæquilateralis*, Gemm.
34. *Spirigera* (*Athyris*) *Roysii*, Lév.
35. " " *expansa*, Phill.
36. " " *subexpansa*, Waag.
37. " " *capillata*, Waag.
38. *Spirigerella grandis*, Waag.
39. " *Derbyi*, Waag.
40. " *pertumida*, Diener.
41. *Retzia* (*Hustedia*) *grandicosta*, Dav. (=*remota*, Eichwald.).
42. *Uncinella cf. indica*, Waag.
43 *Enteletes Tschernyschewi*, Diener.
44. " *Waageni*, Gemm.
45. " *subæquivalvis*, Gemm.
46. *Terebratuloidea cf. depressa*, Waag.
47. *Uncinulus timorensis*, Beyr.
48. " *jabiensis*, Waag.
49. *Camarophoria Purdoni*, Dav.
50. " *Purdoni var. gigantea*, Diener.
51. " *cf. semiplicata*, Gemm.
52. " *globulina*, Phill.

53. *Camarophoria aff. crumena*, Mart.
54. *Hemiptychina sublævis*, Waag.
55. *Hemiptychina sparsiplicata*, Waag.
56. „ *himalayensis*, Dav.
57. „ *inflata*, Waag.
58. *Dielasma elongatum*, Schloth.
59. „ *plica*, Kut.
60. „ *biplex*, Waag
61. „ sp. ind. aff. *hastaforme*, Kon.
62. *Notothyris triplicata*, Diener.
63 „ *mediterranea*, Gemm.
64. „ *exilis*, Gemm.
65. „ *cf. subvesicularis*, Dav.
66. „ *Walkeri*, Diener.
67. *Richthofenia*, sp. ind.

### *Bryozoa.*

68. *Fenestella*, sp. ind.

### *Crinoidea.*

69. *Poteriocrinus*, sp. ind.

### *Spongiæ.*

70. *Amblysiphonella aff. vesiculosa*, Kon.

### *Anthozoa.*

71. *Amplexus coralloides* var. *Abichi*, Waag. et Wentz.
72. *Zaphrentis Beyrichi*, Rothpletz.
73. *Clisiophyllum*, sp. ind.
74. *Dibunophyllum*, sp. ind.
75. *Pterophyllum*, sp. ind.
76. *Lonsdaleia indica*, Waag. et Wentz

Altogether 76 species, among which the Brachiopoda numbering 59 species by far predominate, both in species and in individuals. Although they compose nearly five-sixths of the entire fauna of the limestone crag of Chitichun No. I, they stand in stratigraphical importance far behind the small number of ammonites which have been found associated with them. Those ammonites permit the geological horizon of the Chitichun limestone to be fixed with full certainty.

In this respect the discovery of *Xenaspis carbonaria*, Waag., in the limestone crag of Chitichun No. I, by Walker is of chief interest. It has been stated by Noetling that Waagen was mistaken in quoting this ammonite from the so-called "Cephalopoda bed" of Jabi, but that the main layer of *Xenaspis carbonaria* is in the topmost beds of the middle Productus limestone, corresponding to Waagen's Kalabagh beds.

In my memoir on the fauna of Chitichun No. I (part 3 of this volume) it has been demonstrated that the distribution of identical species indicates a homotaxis of the Chitichun limestone with the upper division of the middle

Productus limestone (Virgal and Kalabagh beds) in the Salt Range. Among 47 species 24 were found to be identical with such forms as occur in the upper division of the middle Productus limestone. Of these 5 were found not to extend into higher strata, whereas the rest had been quoted by Waagen both from the middle and upper Productus limestone. But there was not a single species of the upper Productus limestone identical with a Chitichun form which did not also occur in the middle Productus limestone. The affinity of the Chitichun fauna consequently appeared to be more intimate with the middle than with the upper Productus limestone. This evidence seemed to be corroborated by the occurrence of three species identical with forms from the Amb beds and Katta beds, which, according to Waagen, do not extend in the Salt Range into higher divisions of the Productus limestone series.

This result of my examination of the fossil materials collected in 1892 has not been altered by my recent examination of Walker's collection. The number of species identical with forms from the upper division of the middle Productus limestone (Virgal and Kalabagh beds) has increased to 27, of which 23 occur also in the upper Productus limestone. But no species of the upper Productus limestone has been met with, which is not common both to the middle and upper divisions of the Productus limestone series. To the three species identical with such forms from the Katta beds, which, according to Waagen, do not extend in the Salt Range into the middle Productus limestone, a fourth (*Uncinella* cf. *indica*) has been added.

Thus, from the general character of the fauna, the homotaxis of the Chitichun limestone with the upper division, or—from the presence of *Xenaspis carbonaria*—rather with the topmost beds of the middle Productus limestone of the Salt Range, seems to be clearly established.

So far there is no reason for any change in my correlation of the Chitichun fauna with Indian faunæ of permian age, as proposed by myself in 1897. I am, however, bound to confess that the affinities of the Chitichun fauna to those of Europe have not been correctly interpreted, and that my examination of Walker's materials is apt to lead in this respect to results remarkably different to those deduced in my first memoir.

In that memoir (pt. 3 of the present volume) the conclusions at which I arrived with regard to the stratigraphical position of the Chitichun fauna were summed up as follows:—

"The Chitichun limestone is approximately homotaxial with the upper division of the middle Productus limestone (Virgal and Kalabagh beds) in the Salt Range. It probably corresponds in age to the permo-carboniferous horizon (Artinskian stage) in Russia, but the description of the Brachiopoda from the Fusulina limestone of Sicily must be awaited before it is possible to decide whether it does not hold a slightly higher position in the stratigraphical sequence than the Artinskian deposits."

This mistake of correlation is the legitimate outcome of an erroneous interpretation of the stratigraphical position of the Salt Range Productus limestone. The supposition "that the entire Productus limestone forms a series, which cannot be separated from the carboniferous system and that the Fusulina-bearing Amb beds certainly belong to the latter," was not my fault. I followed the majority of European palæontologists in this, and my error was due to the ignorance of the leading palæontologists as to the right means of correlating rock-equivalents of anthracolithic age in Europe and in India.

Waagen believed the Productus limestone to be permian, but to represent the entire permian system. He consequently correlated the lower Productus limestone and the Katta beds of the middle Productus limestone with the Artinskian stage of Russia, considering them as permo-carboniferous. The palæontological investigations of Nikitin, Frech and Tschernyschew raised doubt as to the validity of this correlation. The affinity of the fauna of the lower Productus limestone to those of the upper carboniferous rocks of Russia and the Ural Mountains and of the Carnian Fusulina limestone of the Eastern Alps induced Rothpletz (Palæontographica, vol. XXXIX, p. 63), Frech (Die Karnischen Alpen, p. 372), Oldham (Manual of the Geology of India, 2nd Edn., p. 125), and Suess (Denkschr. kais. Akad. d. Wissensch. Wien, math. nat. Cl., vol. LXI, p. 439) to correlate the lower Productus limestone with upper carboniferous rather than with permo-carboniferous beds. In the meantime Tschernyschew called attention to the strongly marked affinities of the faunæ of the middle Productus limestone and the Artinskian stage. On palæontological grounds he tried to prove that the entire middle Productus limestone ought to be synchronised with the Artinskian strata of Russia.

In admitting this homotaxis I merely followed the almost unanimous judgment of European geologists. The equivalence of the Chitichun limestone to the Virgal and Kalabagh beds in the Salt Range having been clearly demonstrated, the necessity of correlating it with the Artinskian stage of Russia was obvious.

I have been convinced of the incorrectness of this correlation both by the recent reports of Dr. Noetling on the classification of the Productus limestone and of the Ceratite formation in the Salt Range, and by my own examination of the fossil materials collected by Walker.

In 1896 Dr. F. Noetling, in a preliminary note on the glacial boulder beds of the Salt Range (Neues Jahrb. f. Min., Bd. II, pp. 61—86), announced that there were no true carboniferous or permo-carboniferous strata represented in the Productus limestone series, which, according to his opinion, must be correlated with the upper division of the permian system, *viz.*, the German Zechstein only. This announcement naturally produced a sensation among palæontologists, and led to new discussions of the problem of correlation. The general equivalence between the Amb beds and the Carnian Fusulina limestone of upper carboniferous age on the one side, and between the middle Productus limestone and the Artinskian strata of Russia on the other, had been asserted by Frech and Tschernyschew, and on their authority had been admitted by the majority of geologists.

From this position Noetling both departed and advanced. In a second paper (Beiträge zur Geologie der Salt Range, insbesondere der permischen und triadischen Ablagerungen, Neues Jahrb. f. Min. Beilagebd., XIV, 1901, pp. 369—471) he reported the discovery of *Xenaspis carbonaria*, Waag., in the topmost bed of the middle Productus limestone. The importance of this discovery consists in the fact that the famous Cephalopoda of permian age, which had first been described by Waagen, are not restricted to the upper Productus limestone, but that one of the most interesting species of triassic aspect, and with ceratitic sutures, has its main layer in the Kalabagh beds of the middle Productus limestone. With this discovery all the arguments in favour of a correlation of the middle Productus limestone with the Artinskian stage fall to the ground. Ammonites with ceratitic sutures are entirely absent in the Artinskian stage. Their presence points even more clearly to the younger horizons of the permian system, than does the first appearance of more highly developed ammonites to the permo-carboniferous stage.

As we have learned since Davidson's and L. de Koninck's publications, many years of study have not enabled geologists to establish with certainty the correlation between the several faunæ of the Productus limestone and of extra-Indian deposits. The imperfection of Waagen's work was mainly due to his ignorance of the exact stratigraphical sequence of the beds of the Productus limestone formation and to the fact that a number of Cephalopoda from his supposed Jabi beds were mainly forms of the middle Productus limestone. The misinterpretation of the relation of the fauna of the middle Productus limestone to the permian faunæ of Europe has been corrected by Noetling. The limit between what is to be strictly referred to permian and older deposits in the Salt Range may yet remain an open question; but to the true position of the middle Productus limestone in the standard stratigraphical scale Noetling's discovery of the main layer of *Xenaspis carbonaria* gave a decisive clue.

Thus all the evidence proves that the upper division of the middle Productus limestone holds a rather high stratigraphical position in the permian system and must probably be placed on a higher level than the permian Fusulina limestone of Sosio in Sicily. The equivalents of the Chitichun limestone, which is homotaxial with the upper division of the middle Productus limestone (Noetling's zone of *Xenodiscus carbonarius*) must consequently be looked for in the permian brackish and inland sea deposits of Russia, corresponding to the German Zechstein, not in the Artinskian stage of the Ural Mountains.

The correlation of the middle Productus limestone with the European Zechstein involved a number of disputed questions in all of which the ammonites recently discovered by Walker in the Chitichun limestone point to the right interpretation. The discovery of *Xenaspis carbonaria* and of a true representative of the genus *Cyclolobus* in the Chitichun fauna clearly proves this fauna to be younger than permo-carboniferous.

In my memoir on the fauna of Chitichun No. I (pt. 3 of this volume), I have not failed to notice the grave objections to which the statistical method of correlation is open, especially where this correlation must rely almost entirely on Brachiopoda alone, "which very generally do not keep strictly to an exact geological horizon and therefore can be used only in rare cases as reliable documents for an identification of a narrowly limited geological stage or zone." At the time when that memoir was written, no Cephalopoda had been discovered in any of the divisions of the middle Productus limestone, and one single ammonite only, *Stacheoceras Trimurti*, had been collected by myself in the Chitichun limestone. This ammonite, however, though of high stratigraphical importance, was found to belong to a genus which is equally distributed in permo-carboniferous and in permian faunæ. Moreover, no description of the rich brachiopod fauna of the Fusulina limestone of Sicily had as yet appeared by which the affinities of the Chitichun fauna to that of Sosio might have been elucidated.

In 1899 the first part of Gemmellaro's monograph on the permian Brachiopoda of Sicily was published. The description of some important groups—*Productidæ*, *Coralliopsidæ*, *Strophomenidæ*—must still be awaited before the affinities of the faunæ of Sosio and of Chitichun No. I can be clearly understood. Notwithstanding this defect, which is increased by Gemmellaro's exceedingly narrow interpretation of species, the relations of the Chitichun fauna to that of Sosio appear to be closer than to the Artinskian fauna. With the latter the Chitichun fauna has twelve species of Brachiopoda in common, two of which (*Spirifer Wynnei*, Waag., and *Martinia semiplana*, Waag.) are doubtful. The sub-orders of *Helicopegmata*, *Ancistropegmata* and *Ancycopegmata* alone are represented in the faunæ of Sosio and Chitichun by twelve or perhaps even fourteen species, which are common to both of them. These species are—

*Spiriferina Margaritæ*, Gemm.
*Spirifer Wynnei*, Waag. (= *Sp. siculus*, Gemm.).
*Martinia elegans*, Dien. (= *M. Distefanoi*, Gemm.).
" *acutomarginalis*, Dien. (= *M. Semiramis*, Gemm.).
*Reticularia cf. lineata*, Mart.
" *pulcherrima*, Gemm.
" *inæquilateralis*, Gemm.
*Enteletes Waageni*, Gemm.
" *subæquivalvis*, Gemm.
*Camarophoria semiplicata*, Gemm.
*Notothyris mediterranea*, Gemm.
" *exilis*, Gemm.

To these species *Spiriferina octoplicata* var. *fastigata*, Schellw., and *Uncinulus jabiensis*, Waag., may be added as doubtful.

The relations of the Chitichun fauna to that of the permo-carboniferous Trogkofelschichten of Carinthia and Carniola, which has been recently described by Schellwien, are less intimate. The following ten species can be quoted as identical:—

*Productus cora*, D'Orb.
" *cancriniformis*, Tschern.
" *semireticulatus*, Mart.
" *gratiosus*, Waag.
*Spiriferina octoplicata* var. *fastigata*, Schellw.
*Spirifer Wynnei*, Waag.
*Reticularia lineata*, Mart.

*Hustedia grandicosta*, Dav. (=*remota*, Eichwald).
*Camarophoria globulina*, Phill.
*Notothyris exilis*, Gemm.

The occurrence of two more species of the Chitichun limestone, *Aulosteges tibeticus*, Dien., and *Dielasma plica*, Kut., is doubtful. *Spirifer tibetanus*, Dien., is represented in the Trogkofelschichten by the var. *occidentalis*, Schellw.

In comparing the faunæ of the Chitichun crag and of the Fusulina limestone of Sicily, we must not overlook the fact that these two sediments have not been deposited under similar conditions. The Fusulina limestone of Sosio is composed of two divisions, the organic remains of which differ considerably. The ammonites are chiefly restricted to the lower division, the "Calcare compatto." In the upper division, the "Calcare grossolano," ammonites are exceedingly rare, but Brachiopoda abound, especially forms with thick shells, as they are peculiar to the vicinity of reefs.

The fauna of the Chitichun crag does not suggest the idea of a reef deposit. Brachiopoda with thick shells (*Richthofenia*) are exceedingly rare. The most typical representatives of this group (*Geyerella, Scacchinella, Megarhynchus*), which abound in the "Calcare grossolano," are completely absent. So are the *Fusulinæ*, whereas single corals (*Amplexus, Zaphrentis*) are very common. Nor does the Chitichun limestone contain any traces of coarse breccia or conglomerate, such as might be expected in the vicinity of a shore-line.

A very peculiar feature in the Chitichun fauna is the extraordinary abundance of *Spirigera* (*Athyris*), which is absent both in the permian rocks of Sicily and in the Trogkofelschichten of the Eastern Alps.

I do not, however, believe that the Chitichun limestone should be placed on a level with the Fusulina limestone of Sicily. So far as it is possible to judge from its Cephalopoda, the Chitichun fauna appears to be geologically younger. Ammonites with ceratitic sutures such as *Xenaspis carbonaria*, or with complicated sutures, such as *Cyclolobus Walkeri*, speak clearly in favour of a homotaxis of the Chitichun limestone with true upper permian strata of Europe.

In my memoir on the fauna of Chitichun No. I (p. 101), the probability of a correlation of the Chitichun limestone with the permian rocks of the island of Timor has been discussed. Twelve species of Brachiopoda were found to be identical in both faunæ. The number of identical species of all classes of fossil remains is now increased to fourteen. To the Brachiopoda, which have been enumerated in my above-quoted memoir, two species of corals, *Amplexus coralloides* var. *Abichi*, Waag. et Wentz., and *Zaphrentis Beyrichi*, Rothpl., must be added. It was only on account of the occurrence of a species of *Cyclolobus* in the permian rocks of Timor, that I came to the conclusion that they ought to be placed on a slightly higher level than the Chitichun limestone. The discovery of *Cyclolobus Walkeri* among the material collected by Walker in 1899 has rendered this view untenable. On the principle of establishing correlation of horizons by identity of the fossils, all the evidence at present goes to prove that the permian limestones of Chitichun No. I and of Timor are homotaxial.

The number of forms identical with the permian Otoceras beds of Djulfa in Armenia is still remarkably small. It amounts to the following four species only :—

*Productus Abichi*, Waag.
*Reticularia pulcherrima*, Gemm.
*Uncinulus jabiensis*, Waag.
*Amplexus coralloides* var. *Abichi*, Waag. et Wentz.

This fact is the more astonishing in that in both rock-groups the genus *Spirigera* (*Athyris*) is most numerously represented. Not a single species of the interesting developmental series of *Spirigera protea*, Abich, and its allies has, however, been recorded from the Chitichun limestone.

At the time when my memoir on the fauna of Chitichun No. I was published eight species of Brachiopoda had not been found outside the crag of Chitichun No. I, and were consequently considered as elements peculiar to its fauna. Since then this number has been considerably reduced. Now only four species out of sixty remain unrecorded from other countries and localities. These species are—

*Spirigerella pertumida*, Dien.
*Camarophoria Purdoni* var. *gigantea*, Dien.
*Notothyris triplicata*, Dien.
" *Walkeri*, Dien.

The occurrence of *Aulosteges tibeticus*, Dien., in the permo-carboniferous Trogkofelschichten of the Eastern Alps and of *Enteletes Tschernyscheffi*, Dien., in the permian Sosio limestone of Sicily is as yet somewhat doubtful.

The evidence afforded by the two species of ammonites which were collected by Walker, together with Noetling's discovery of the true horizon of *Xenaspis carbonaria* in the Productus limestone of the Salt Range, is sufficiently strong to affect my view as to the correlation of the Chitichun limestone with permian beds of other countries, and obliges me to consider the latter as about homotaxial with the permian rocks of Timor and as slightly younger than the Sosio limestone of Sicily. I am therefore compelled to admit the correctness of Noetling's statement that there is at present no proof of the existence of a fauna of Artinskian age in the Himalayas.

There is, however, one case in which I cannot agree with Noetling's view. From a preliminary inspection of Walker's materials, Noetling ( l. c., p. 446 ) was led to the opinion that two faunæ of different ages were mixed together in the Chitichun limestone, an older one with *Productus semireticulatus*, Mart., and a younger one, which might possibly be homotaxial with the faunæ of the middle and upper Productus limestones. Thus he endeavoured to show that beds of carboniferous and permian age had been squeezed together in the crag of Chitichun No. I.

To me this appears to be a misinterpretation of the true character of the Chitichun fauna, mainly due to the prejudice that *Productus semireticulatus* indicates a carboniferous age of the beds in which it occurs as one of the leading fossils. If the presence of *Productus semireticulatus* together with a majority of permian species is to be considered as a decisive proof of a mixture of two faunæ of different ages, we are forced to suppose an equal mixture in the fauna of Timor, where *Productus semireticulatus* is likewise associated with a majority of permian species.

The testimony of the fossils themselves may be called against such assertions. In my own collections from Chitichun No. I there is a rock-specimen containing ventral valves of *Productus semireticulatus* and *P. chitichunensis*, a species which is most probably identical with a permian one from Timor. I can assert, moreover, on the ground of personal knowledge of the crag of Chitichun No. I, that *Productus semireticulatus* is not restricted to certain parts of the crag, but equally distributed throughout the entire mass of white, or white and red, limestones. The possibility of two or more stratigraphical horizons being mixed together within a crag which marks a zone of structural disturbance cannot be denied, but this theoretical possibility must in a given case be supported by facts before it can be taken as a substantial basis for further conclusions.

Both from my personal knowledge of the locality in question and from my examination of the fossil materials I am convinced of the fact that the Chitichun fauna described in the foregoing pages is the fauna of a single distinct horizon, which corresponds in age to the topmost beds of the middle Productus limestone of the Salt Range and takes a higher place in the Permian of the European standard than the Sosio limestone of Sicily and the Rothliegende of Germany.

I am perhaps right in supposing that Dr. Noetling was chiefly led to his hypothesis of an assemblage of two different faunæ—a carboniferous and a permian one—in the Chitichun limestone, by my incorrect correlation of the Chitichun fauna with the Artinskian fauna of Russia, and that he will maintain his view no longer, since our difference of opinion about the homotaxis of the Salt Range Productus limestone has been settled in favour of his conclusions.

The names and stratigraphical distribution of all the species of Chitichun fossils which have been found in other countries are shown in the following tabular statement:—

*Statement showing the distribution of the Chitichun Permian Fauna in other regions.*

| | Upper carboniferous rocks of Lo-ping (China). | SALT RANGE. | | | | Productus (Kuling) shales, Himalayas. | Permian Otoceras beds of Djulfa. | EASTERN ALPS. | | Permian rocks of Sicily. | Permian rocks of Timor. | RUSSIA. | | | Carboniferous and permian rocks of North and South America. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lower Productus limestone. | Middle Productus limestone. | | Upper Productus limestone. | | | Upper carboniferous Fusulina limestone. | Permo-carboniferous Trogkofelschichten. | | | Moscovian and Gshelian stage in Central Russia. | Upper carboniferous rocks of the Ural Mountains. | Artinskian stage. | |
| | | | Katta beds. | Virgal and Kalabagh beds. | | | | | | | | | | | |
| Productus cora, D'Orb | . | i | i | i | i | . | . | i | i | . | . | i | i | i | i |
| „ semireticulatus, Mart. | i | i(?) | . | . | . | . | . | i | i | . | i | i | i | i | i |
| „ chitichunensis, Dien. | . | . | . | . | . | . | . | . | . | . | i | . | . | . | . |
| „ cf. subcostatus, Waag. | . | . | . | i(?) | i(?) | . | . | . | . | . | . | . | . | . | . |
| „ gratiosus, Waag. | . | . | i | i | i | . | . | . | i | . | i | . | . | . | . |
| „ cancriniformis, Tschern. | . | . | . | . | . | i | . | i | i | . | . | . | . | i | . |
| „ Abichi, Waag. | . | . | . | i | i | . | i | . | . | . | i | . | . | . | . |
| „ mongolicus, Dien. | i | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Marginifera typica, Waag. | . | . | i | i | i | . | . | . | . | . | . | . | . | i | . |
| Aulosteges tibeticus, Dien. | . | . | . | . | . | . | . | . | i(?) | . | . | . | . | . | . |
| Lyttonia nobilis, Waag. | . | . | . | i | i | . | . | . | . | . | . | . | . | . | . |
| Spiriferina octoplicata *var.* fastigata, Schellw. | . | i | i | i | i | . | . | . | i | i(?) | i | . | i | i | . |
| Spiriferina Margaritæ, Gemm. | . | . | . | . | . | . | . | . | . | i | . | . | . | . | . |
| Spirifer fasciger, Keyserl. | . | i | i | i | i | i | . | i | . | . | i | . | i | i | . |
| „ tibetanus, Dien. | . | . | | . | . | . | . | . | . | . | . | . | i | . | . |
| „ Wynnei, Waag. | . | . | . | i | . | . | . | . | i | i | . | . | . | i(?) | i |
| Martinia cf. glabra, Mart. | . | . | . | . | . | . | . | . | . | i(?) | . | . | . | . | . |
| „ elegans, Dien. | . | . | . | . | . | . | . | . | . | i | . | . | . | . | . |
| „ nucula, Rothpl. | . | . | . | . | . | . | . | . | . | . | i | . | . | . | . |
| „ semiplana, Waag. | . | . | . | i | . | . | . | i | . | . | . | . | . | i(?) | . |
| „ acutomarginalis, Dien. | . | . | . | . | . | . | . | . | . | i | . | . | . | . | . |
| „ contracta, Meek et Worth. | . | . | . | . | . | . | . | . | . | . | . | . | . | . | i |
| Reticularia cf. lineata, Mart. | . | . | . | . | . | . | . | . | i | i | . | . | i | . | . |
| „ pulcherrima, Gemm. | . | . | . | . | . | . | i | . | . | i | . | . | . | . | . |
| „ inæquilateralis, Gemm. | . | . | . | . | . | . | . | . | . | i | . | . | . | . | . |
| Spirigera Royssii, Lév. | . | i | i | i | i | i | . | i | . | . | i | i | . | i | . |
| „ expansa, Phill. | . | . | . | . | . | . | . | . | . | . | . | i | . | . | . |
| „ subexpansa, Waag. | . | . | i | i | i | . | . | . | . | . | . | . | . | . | . |

*Statement showing the distribution of the Chitichun Permian Fauna in other regions*—continued.

| | | SALT RANGE. | | | | | | EASTERN ALPS. | | | | RUSSIA. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Upper carboniferous rocks of Loping (China). | Lower Productus limestone. | Middle Productus limestone. Katta beds. | Middle Productus limestone. Virgal and Kalabagh beds. | Upper Productus limestone. | Productus (Kuling) shales, Himalayas. | Permian Otoceras beds of Djulfa. | Upper carboniferous Fusulina limestone. | Permo-carboniferous Trogkofelschichten. | Permian rocks of Sicily. | Permian rocks of Timor. | Moscovian and Gshelian stage in Central Russia. | Upper carboniferous rocks of the Ural Mountains. | Artinskian stage. | Carboniferous and permian rocks of North and South America. |
| Spirigera capillata, Waag. | . | . | . | i | i | . | . | . | . | . | i | . | . | . | . |
| Spirigerella grandis, Waag. | . | . | . | i | i | . | . | . | . | . | . | . | . | . | . |
| " Derbyi, Waag. | . | . | . | i | i | i | . | . | . | . | . | . | . | . | i |
| Retzia (Hustedia) grandicosta, Dav. | i | i | i | i | i | . | . | . | i | . | i | i | i | . | . |
| Uncinella cf. indica, Waag. | . | . | i | . | . | . | . | . | . | . | . | . | . | . | . |
| Enteletes Waageni, Gemm. | . | . | . | . | . | . | . | . | . | i | . | . | . | . | . |
| " subæquivalvis, Gemm. | . | . | . | . | . | . | . | . | . | i | . | . | . | . | . |
| Terebratuloides cf. depressa, Waag. | . | . | . | i | . | . | . | . | . | . | . | . | . | . | . |
| Uncinulus timorensis, Beyr. | . | . | . | i | i | . | . | . | . | . | i | . | . | . | . |
| " jabiensis, Waag. | . | . | . | . | i | . | i | . | . | i(?) | . | . | . | . | . |
| Camarophoria Purdoni, Dav. | . | . | . | i | i | . | . | . | . | . | . | i | . | i | . |
| " cf. semiplicata, Gemm. | . | . | . | . | . | . | . | . | . | i | . | . | . | . | . |
| " globulina, Phill. | . | . | . | . | i | . | . | . | i | . | . | . | . | . | . |
| Hemiptychina sublævis, Waag. | . | i | . | . | . | . | . | . | . | . | . | . | i | . | . |
| " sparsiplicata, Waag. | . | i | i | i | . | . | . | . | . | . | i | . | . | . | . |
| " himalayensis, Dav. | . | i | i | i | i | . | . | . | . | . | . | . | . | . | . |
| " inflata, Waag. | . | . | . | i | i | . | . | . | . | . | . | . | . | . | . |
| Dielasma elongatum, Schloth. | . | . | i | . | . | . | . | . | . | . | . | i | i | i | . |
| " biplex, Waag. | . | . | . | i | . | . | . | . | . | . | . | . | . | . | . |
| " plica, Kutorga | . | . | . | . | . | . | . | . | i(?) | . | . | . | i | . | . |
| Notothyris mediterranea, Gemm. | . | . | . | . | . | . | . | . | . | i | . | . | . | . | . |
| " exilis, Gemm. | . | . | . | . | . | . | . | . | i | i | . | . | . | . | . |
| " cf. subvesicularis, Dav. | . | . | . | i | i | . | . | . | . | . | . | . | . | . | . |
| | 3 | 10(1?) | 13 | [illegible](1?) | 32(1?) | 4 | 3 | 7 | 12(2?) | 14(2?) | 12 | 8 | 11 | 13(2?) | 5 |
| Xenaspis carbonaria, Waag. | . | . | . | i | . | . | . | . | . | . | . | . | . | . | . |
| Amplexus coralloides *var.* Abichi, Waag. et Wentz. | . | . | . | i | i | . | i | . | . | . | i | . | . | . | . |
| Zaphrentis Beyrichi, Rothpl. | . | . | . | . | . | . | . | . | . | . | i | . | . | . | . |
| Lonsdaleia indica, Waag. et Wentz. | . | . | . | i | i | . | . | . | . | . | . | . | . | . | . |
| | . | . | . | [illegible](1?) | 34(1?) | . | 4 | . | . | . | 14 | . | . | . | . |

## II.—PERMIAN FOSSILS FROM THE EXOTIC BLOCK No. 9 IN THE NEIGHBOURHOOD OF MALLA SANGCHA E. G.

During the months of July and August, 1900, the late Dr. A. von Krafft spent six weeks in the frontier district of Malla Johar, and found it to abound with exotic blocks. Among them some blocks of permian age were discovered.

The permian limestone is described by A. v. Krafft, in his memoir on the exotic blocks of Malla Johar, as a massive, light grey and red, marble-like crinoid limestone with many cleavage-planes. Large sections of crinoid stems form a most characteristic feature. Blocks of this age rarely exceed 30 to 50 feet in diameter. They were chiefly traced in the hills to the N.-W. and W. of the Kiogarh-Chitichun Pass. One of the blocks only, which has been marked as E. B. No. 9 on the map accompanying Dr. A. von Krafft's memoir, is of larger dimensions. It yielded a large number of fossils, the majority of which are tolerably well preserved and permit a satisfactory identification.

A provisional list of fossils, based on a cursory examination of the materials from this locality, was communicated by myself to Dr. v. Krafft in July 1901, and is given on p. 141 of his memoir.

My subsequent examination has not obliged me to correct any of the identifications given in that list, but has proved the fauna of this exotic block to be still richer in species, confirming my statement as to its permian age.

### LAMELLIBRANCHIATA.

#### AVICULOPECTEN cf. HIEMALIS, Salter.

1865. *Aviculopecten hiemalis*, Salter. Palæontology of Niti in the Northern Himalayas, by J. W. Salter and H. F. Blanford. Calcutta, p. 55, Pl. V, fig. 14.

1897. *Aviculopecten hiemalis*, Diener. The permian fossils of the Productus shales of Garhwâl and Kumaon, Palæont. Indica, ser. XV, Himalayan Foss., vol. I, pt. 4, p. 9, pt. V, figs. 10, 11.

The incomplete fragment of a left valve is provisionally and with much hesitation referred to this common species of the permian Productus, or Kuling, shales of the Central Himalayas on account of its external sculpture. In its ornamentation the present fragment agrees completely with my type-specimen of *A. hiemalis* from Kiunglung E. G., exhibiting three different classes of ribs, which are unequal in strength and size, and very numerous concentric lines of growth. As, however, the umbonal region of my fragment has been entirely broken off, an exact determination is quite impossible, the number of species which are provided with a similar sculpture being fairly large. *Aviculopecten Kokscharoffi*, Vern., *A. Bouei* Vern., *A. Draschei*, Toula, *A. ægyptiacus*, Walther, are among such species, to which the present fragment might be compared with as much right as to *A. hiemalis*.

*Number of specimens examined.*—1.

### LEIOPTERIA, sp. ind.

The incomplete fragment of a right valve may be referred with some hesitation to the genus *Leiopteria* on account of its external similarity to certain types, such as *L. hirundo*, de Kon., or *L. navicula*, de Kon. A specific determination is impossible. My fragment is of large size, exceeding 40 mm. in length. It is provided with a large, strongly-arched umbo, which is directed towards the anterior wing. The valve is strongly vaulted along its median line, sloping very gradually to the posterior wing but very steeply to the anterior one. Neither of the wings has been preserved.

*Number of specimens examined.*—1.

### LIMA sp. ind. aff. RETIFERA, Shumard, Pl. III, figs. 1, 2.

There are two specimens of this species in A. von Krafft's collection, a single right valve and a complete example consisting of both valves, but without wings.

The complete example is nearly equivalve, the left valve being a little inferior in size to the opposite one, but not more than is the case in many species of *Limatula*. Its shape is obliquely oval and of nearly equal length and height. Both valves are equally and moderately vaulted and markedly inequilateral. The anterior margin forms a broad curve and is continuous with the regularly rounded ventral margin, which passes into the posterior margin at an obtusely rounded-off angle. From this angle the posterior margin ascends in a nearly straight line, passing gradually into the furrow which separates the posterior wing from the remainder of the shell. The apex is somewhat posterior in its position, little prominent beyond the hinge-line, but distinctly incurved.

In my example consisting of both valves the wings have been broken off entirely. In my second specimen, which is represented by a single right valve, only slight traces of the anterior wing have been noticed. But the posterior wing is tolerably well preserved. It is high, narrow, and marked off from the remainder of the shell by a slight sinuation. Its surface is perfectly smooth.

Both valves are covered with a very distinct radiating sculpture. This sculpture consists of simple, almost equally strong costæ, which originate in the apex and extend to the ventral margin. The ribs are not sharp but rounded on their tops and narrower than the intercostal valleys. The number of ribs is from 18 to 20 on one valve. The radiating sculpture is crossed by very numerous and delicate concentric or incremental lines.

The measurements of the complete specimen are as follows :—

| | |
|---|---|
| Entire length of the shell . . . . . . . | 21 mm. |
| „ height „ . . . . . . . | 22 „ |
| Thickness of both valves . . . . . . . | 9 „ |

The shell which bears the greatest resemblance to the present species is *Lima* *retifera*, Shumard. How far the two species resemble each other may be seen from a comparison of my illustrations and of the figures of *L. retifera*, as given by Geinitz (Carbonformation und Dyas in Nebraska, Pl. II, figs. 20, 21) and Meek (Geological Survey of Illinois, vol. V, Palæontology, Pl. XXVI, fig. 2, and Palæontology of Eastern Nebraska, in Meek and Hayden's Final Report upon the U. S. Geol. Surv. of Nebraska, Washington, 1872, Pl. IX, fig. 5). They are, however, certainly not identical. The Himalayan shell is considerably larger, and its ornamentation differs by a smaller number of ribs—twenty-five being present in the American species—which are rounded above, not angular, as in *L. retifera*.

In the latter character our species agrees with *Lima retiferiformis*, Netschajew (Die Fauna der permischen Ablagerungen des oestlichen Theiles des europæischen Russlands, Trudy of the Imperial University of Kasan, T. XXVII, pt. 4, p. 192, Pl. VI, figs. 18, 19). From the latter species it is, however, easily distinguished by its other characters, which induced the Russian author to separate his form from *L. retifera*. *Lima kazanensis*, Netschajew, (Pl. c., p. 193, Pl. XI, fig. 6) is also among the nearest allies of my Himalayan shell, but the great difference in size makes distinction fairly easy.

Among the Lamellibranchiata from the permian Fusulina limestone of Sicily, *Lima subretifera*, Gemmellaro (La fauna dei calcari con Fusulina della valle del F. Sosio, Fasc. III, p. 227, Pl. XXIV, fig. 11) seems to be nearly allied to our Himalayan species, from which it differs by its smaller dimensions and by a truncated, instead of a regularly rounded, anterior margin.

The affinity of the present shell to other species of *Lima* is rather distant. *Lima Haueriana*, L. de Koninck (Monographie des Foss. carbonifères de Bleiberg, Bruxelles, 1873, p. 93, Pl. III, fig. 32), though exhibiting a remarkable similarity in its sculpture, differs in its general shape by being considerably higher than long. *Lima Footei*, Waagen (Salt Range Foss., Palæont. Indica, ser. XIII, vol. I, Productus Limestone Foss., p. 298, Pl. XX, figs. 14, 15), is more elongately oval and covered with more delicate and numerous ribs, some of which reach the apex of the shell.

## GASTEROPODA.

### NATICOPSIS KHURENSIS, Waagen, Pl. III, fig. 3.

1880. *Naticopsis kurensis*, Waagen. Salt Range Foss., Palæont. Indica, ser. XIII, vol. I, Product. Limestone Foss., p. 100, Pl. IX, fig. 10.

This species is represented in A. v. Krafft's collection by a single, but fairly well-preserved, specimen, which permits of accurate determination.

The measurements of this specimen are as follows:—

| | |
|---|---|
| Entire length of the shell | 43 mm. |
| Greatest breadth of the shell | 40 „ |
| Height of the last volution at the aperture | 36 „ |
| Breadth of the aperture | 24 „ |
| Apical angle | ca. 118° |

My specimen agrees in every respect so perfectly with the figures and description of *Naticopsis khurensis*, as given by Waagen, that a detailed enumeration of its characters is scarcely necessary. The slightly prominent and angular shelly part, in which the two lips of the aperture unite anteriorly, is especially well marked and closely resembles Waagen's illustration (l. c., Pl. IX, fig. 10 *d*). The inner lip is smooth, flattened and only slightly thickened, thus exhibiting the principal characters of *Naticopsis*, as stated in M'Coy's diagnosis of this genus.

The embryonal portion of the innermost volution has not been preserved.

Professor Waagen considers ***Naticopsis simlaënsis***, Guembel, as the species which is most nearly allied to the present form, and from which, in his opinion, it can only be distinguished by the less flattened sutural part of the whorls. I am, however, not so certain whether the character mentioned by Waagen can really be claimed as a distinguishing feature between *Naticopsis khurensis*, Waag., and *N. simlaënsis*, Guemb. Geheimrath C. v. Guembel's illustration of *N. simlaënsis* so closely agrees in shape and dimensions with my Himalayan example, that I should have at once referred the latter to that species without Waagen's statement as to the specific independence of *N. simlaënsis* and *N. khurensis*. C. v. Guembel in his memoir on the presence of beds of lower triassic age in the Himalayas (Ueber das Vorkommen von unteren Triasschichten in Hochasien, nach den von den Gebruedern Schlagintweit gesammelten Fundstücken beurtheilt, Sitzgsber. kgl. bayr. Akad. d. Wissensch. Muenchen, 1865, Pt. II, p. 365) quotes his species from a dark limestone from Dharampur in the province of Simla. But the specimens which were collected by the brothers Schlagintweit can by no means be regarded with certainty as having really been found in the district of Simla. It has been clearly shown by A. von Krafft in his note on the presence of Werfen beds in the Himalayas (Centralblatt f. Miner., etc., 1901, p. 197) that all the statements of the brothers Schlagintweit as to the localities from which their fossils have been derived, are entirely misleading and untrustworthy. Nor is there any certainty regarding the geological horizon of *N. simlaënsis*, even on the ground of Guembel's conclusions. But before this is decided it will be advisable to separate *N. simlaënsis* and *N. khurensis*, however slight the differences between the two forms may appear, especially if one is obliged to judge only from the figures, which are not very well executed and accompanied by only very short descriptions. The probability that the specific identity of both might be fully established cannot, however, be excluded.

There are very few species of *Naticopsis* with which the present one could be particularly compared. Among the Belgian species of lower carboniferous age, which have been described and illustrated by L. de Koninck, *N. propinqua*, de Kon. (Faune du calcaire carbonifère de la Belgique, Annales du Musée R. d'hist. nat., T. VI, 3ème ptie., p. 18, pl. I, figs. 4, 5), and *N. consimilis*, de Kon. (*ibidem*, p. 22, Pl. II, figs. 4—6), strongly resemble *N. khurensis*. *N. propinqua* differs from our Indian species by its broader and posteriorly rounded aperture, and by the presence of numerous small folds in the vicinity of the sutures. *N. consimilis* is likewise distinguished by its more regularly oval aperture and by its shorter spire, the length of which is considerably less than the breadth of the shell.

Among the permian species from the Fusulina limestone of Sicily, ***Nat. Waageni***, Gemmellaro (La fauna dei calcari con Fusulina della valle del F. Sosio, Fasc. II, Palermo, 1889, p. 131, Pl. XVIII, figs. 2, 3), and ***N. mediterranea*** (*ibidem*, p. 132, Pl. XVIII, figs. 10, 11) exhibit a distant similarity with ***Nat. khurensis***. But in the Indian form the length of the spire is considerably larger in proportion to the breadth of the shell than in the first-mentioned species, the aperture is less regularly rounded, the inner lip especially being more straight, whereas *N. mediterranea* chiefly differs from *N. khurensis* by its inner volutions being more strongly inflated and prominent above the suture.

Of American species *Naticopsis subovata*, Meek et Worthen (Geological Survey of Illinois, vol. V, Palæontology, p. 595, Pl. 38, fig. 1), might be compared, but likewise differs from *N. khurensis* by its shorter spire and by its regularly rounded aperture.

If to the three groups which Meek and Worthen have distinguished among the genus *Naticopsis* a sub-generic value should be granted, our Indian species ought to remain in the genus *Naticopsis* (*sensu stricto*), of which *N. Phillipsi*, M'Coy, is the prototype.

*Naticopsis khurensis* has been quoted by Waagen from the upper limit of the Productus limestone of the Salt Range.

### BELLEROPHON sp. ind. aff. POLITO, Waagen, Pl. III, fig. 4.

A single, incomplete specimen of a small *Bellerophon* may be compared to *B. politus*, Waagen (Salt Range Fossils, Palæontologia Indica, ser. XIII, vol. I, Productus Limestone Foss., p. 148, Pl. XII, fig. 6), to which at least it seems to be very nearly related.

The whorls are strongly inflated, broader than high, and forming a comparatively large transversely oval aperture. They envelop each other almost entirely, leaving open only a very small umbilicus. The aperture is not completely preserved. Consequently the median slit-band cannot be noticed, but its presence is marked in the cast by a median keel, which gradually disappears near the beginning of the last volution. In the umbilical region of the aperture small lateral expansions are developed.

The surface of the cast is perfectly smooth.

The measurements of this specimen are as follows :—

| | | | |
|---|---|---|---|
| Diameter of the shell | | 15 | mm. |
| Greatest breadth of the aperture | | 11 | „ |
| Height of the aperture | from the top of the preceding whorl | 6·5 | „ |
| | from the lower margin of the last expansion | 9 | „ |

*Belleropkon politus*, Waagen, from the upper Productus limestone of the Salt Range bears the greatest resemblance to my Himalayan example. In Waagen's type-specimen from Khund Ghât the aperture is still broader, and the lateral parts, which slope from the elevated median keel to the small umbilical groove, are more narrowly rounded. In both characters my specimen forms an intermediate link between *Bellerophon politus* and *B. vigilii*, Stache (Jahrb. K. K. Geol. Reichs-Anst., XXVII, 1877, p. 298, Pl. II, fig. 2), from the permian Bellerophon limestone of the Eastern Alps. It is, however, distinguished from the latter species by the shape of the umbilical region, which, in casts of *B. vigilii*, partly exhibits the inner volutions within the comparatively wide and deep umbilicus.

*Bellerophon tenuifascia*, Sow., one of the leading species of the Belgian mountain-limestone, is also among the nearest allies of our Himalayan form, from which it differs by the same characters as *B. politus* and by the presence of callous lateral expansions, which in full-grown specimens of *B. tenuifascia* completely close the umbilical groove.

In *Bellerophon sublævis*, Hall[1] (Rep. Geol. Surv. of Iowa, vol. I, pt. 2, p. 666, Pl. 23, fig. 15) the whorls are more strongly depressed, the keel is not distinctly marked and the lateral expansions of the aperture are so strongly developed that they almost cover the small umbilical groove.

Among the *Bellerophontidæ* of the permian Fusulina limestone of Sicily, which have been described and illustrated by Gemmellaro, there is no species which could be more nearly compared to the present one.

*Number of specimens examined.*—1.

### PLEUROTOMARIA (MOURLONIA) HUNICA, nov. sp., Pl. III, fig. 5.

The general shape of this beautiful species is depressed, conical, considerably broader than high. The spire is rather depressed, and consists of five or six volutions, the last of which occupies nearly three-quarters of the entire height.

The last volution is of sub-angular shape. Its upper portion is a little more strongly convex than the lower one. Both unite in a narrowly rounded edge. This edge does not correspond to the slit-band, which is situated a little above and is consequently entirely exposed on the upper volutions outside the suture.

The slit-band is moderately broad, flat and accompanied on both sides by low and narrow ridges, the lower of which is not far from the suture. The suture between the single whorls is sharply incised and very distinctly marked. Immediately below the suture the volutions are nearly horizontal for a short distance, before becoming convex and sloping in a faintly arched curve to the slightly impressed zone of the slit-band.

The base of the species is rounded, with a moderately wide and deep umbilicus in the middle. The aperture is transversely oval. Its outer lip has been partly injured, especially so in the vicinity of the slit. It is provided with a shallow sinuation at its lower angle.

---

[1] The specific name of the American species must be changed, having been attributed to a species of the Belgian mountain limestone in 1838 by Potiez and Michauld, as has been stated by L. de Koninck (l. c., T. VIII, 4ème ptie., p. 126).

The measurements of my type-specimen are as follows:—

| | | | |
|---|---|---|---|
| Entire length of the shell | | 24 | mm. |
| " breadth " " " | | 35 | " |
| Length | of the spire | 13 | " |
| Breadth | | 23 | " |
| Length | of the aperture | 12 | " |
| Breadth | | 17 | " |
| Diameter of the umbilicus | | ca. 7 | " |
| Apical angle | | 105° | |

The shelly layer is only partly preserved. It is covered with very numerous and delicate transverse striations, which are closely arranged and cross the spiral ridges in a retrograde direction.

A second specimen, belonging to the same species, is of much smaller size, measuring only 12 mm. in length and 17·5 mm. in breadth.

*Number of specimens examined.*—2.

***Remarks.***—The present species must, undoubtedly, be attributed to a section of ***Pleurotomaria***, which, in 1883, was elevated to the rank of a proper genus—***Mourlonia***—by L. de Koninck (Faune du calcaire carbonifère de la Belgique, Annales Musée Roy. d'hist nat., T. VIII., 4ème ptie., p. 75). It agrees with the typical species of ***Mourlonia*** from the Belgian mountain limestone in the presence of a wide and deep umbilicus and of a slit-band, which is situated in the immediate vicinity of the suture, and accompanied by two bordering ridges. It differs from the nearly allied genera ***Ptychomphalus***, ***Gosseletia***, ***Worthonia***, ***Ivania*** (***Baylea***) by the shape of its umbilicus, from ***Agnesia*** by its regularly coiled whorls, from ***Luciella*** by the position of its slit-band.

It must, however, be borne in mind, that according to Koken (über die Entwicklung der Gasteropoden vom Cambrium bis zur Trias, Neues Jahrb. f. Miner. Beil. Bd. VI, 1889, p. 352), L. de Koninck's genus *Mourlonia* is altogether untenable, having been founded on characters whose generic importance is strongly refuted by Koken.

Among the lower carboniferous species of Western Europe there is none which could be compared more closely with the present one. ***Mourlonia euomphaloides*** de Koninck (l. c., p. 87, Pl. XXIV, figs. 11, 12) somewhat resembles it in its ornamentation, but is at once distinguished by its elongately oval shape and by its very large and circular aperture. In general shape ***M. hunica*** is more similar to ***Ptychomphalus sublævis***, de Koninck (l. c., Pl. XXIV, figs. 13, 14), yet important points of difference preclude their being considered as nearly allied species. In ***Pt. sublævis*** the spire consists of more rapidly increasing whorls, the slit-band occupies the median zone of the body whorl, and the umbilicus is not distinctly marked.

It is rather difficult to ascertain the true relations of ***Mourlonia hunica*** to the species from the permian Fusulina limestone of Sicily which have been united in the genus *Pleurotomaria* by Gemmellaro. *Pleurotomaria Mariani*, Gemmel. (La fauna dei calcari con Fusulina della valle del f. Sosio, Fasc. II, p. 167, Pl. XIII, figs. 27—31; Pl. XIV, figs. 1—10, Pl. XIX, fig. 12), which probably belongs to the subgenus ***Ptychomphalus***, so far as one may judge from the shape of the false umbilicus, strongly recalls the present species in the character of its ornamentation, but is of more longately conical, almost trochiform shape, its apical angle varying from 74° to 83°.

The species of *Pleurotomaria* from the Productus limestone of the Salt Range, which have been described and illustrated by Waagen, undoubtedly belong to sections of this genus, which are very different from the group of forms represented by ***Mourlonia hunica.***

## BRACHIOPODA.

### PRODUCTUS ABICHI, Waagen.

1884. ***Productus Abichi***, Waagen, Salt Range Fossils, Palæont. Indica, ser. XIII, vol. I, Productus Limestone Foss., p. 697, Pl. LXXIV, figs. 1—17.

For a complete list of synonyms I refer to my memoir on the fauna of Chitichun No. I, (Pt. 3 of the present volume, p. 26). To these synonyms the following should be added—

1899. ***Productus Abichi***, Diener, Himalayan Foss., Palæont. Indica, ser. XV, vol. I. Pl. 2, Anthracolithic Foss. of Kashmir and Spiti, p. 33, Pl. I, fig. 8.

1900. ***Productus Abichi***, G. v. Arthaber, Ueber das Palæozoicum in Hocharmenien und Persien, Beiträge zur Geol. u. Palæont. Oesterreich-Ungarns, etc., XII, p. 252, Taf. XX, fig. 1.

Of this beautifully sculptured species three tolerably well preserved ventral valves have been found among the fossil materials collected by A. v. Krafft in 1900. All of them are of median size, moderately inflated, provided with a strongly attenuated apical region and with a distinct sinus. In all these characters they agree most nearly with my examples of ***P. Abichi*** from the permian limestone crag of Chitichun No. I.

My largest specimen measures 28 mm. in length and 35 mm. in breadth. Regarding these dimensions, I think myself justified in identifying it with ***P. Abichi***, not with the very nearly allied ***Prod. gangeticus***, Dien., which is distinguished from the former species by the internal arrangement of its dorsal valve.

A very interesting species from the German Zechstein has been quoted among the nearest allies of ***P. Abichi*** by G. v. Arthaber. This species is ***Prod. Geinitzianus*** var. ***geranus***, Eisel (l. c., p. 254, Pl. XXI, fig. 1). To me the true relations of the German species to ***Prod. Abichi*** do not appear to be very close. Notwithstanding its external similarity to ***Prod. Humboldti*** and its allies, it is a typical representative of the group of "horridi" which differs from ***P. Abichi*** not only by its longer hinge-line and by the development of distinct, slightly inflated wings, but also by its much coarser ornamentation.

*Number of specimens examined.*—3.

### PRODUCTUS CHITICHUNENSIS, Diener, Pl. III, fig. 8.

1892. ***Productus***, sp. ind., Rothpletz. Die Perm. Trias und Juraformation auf Timor und Rotti Paleontographica, 39 Bd., p. 77, Pl. X, figs. 17, 18.

1897. ***Productus boliviensis var. chitichunensis***, Diener. The permocarb. fauna of Chitichun No. I Palæont. Indica, ser. XV, Himalayan Fossils, vol. I., pt. 3, p. 20, Pl. II. figs. 2, 4.

(?) 1898. ***Productus semireticulatus***, Loczy, Die wissenschaftlichen Ergebnisse der Reise des Grafen Bela Szechenyi in Ostasien, III Bd., Abth. VI, p. 59, Taf. I, fig. 28.

In my memoir on the fauna of Chitichun No. I a species of ***Productus*** has been referred to ***P. boliviensis***, d'Orb., as a variety which is distinguished from ***Prod. semireticulatus***, Mart., by its remarkably well-developed auriculate expansions and by its delicate sculpture. A specific separation of ***P. boliviensis*** from

*P. semireticulatus* is, in my opinion, justified by the development of large wings, the strong curvature of the spirally-enrolled ventral valve, and the transversely elongated shape. In this view the majority of authors agree notwithstanding Grünewaldt's and Schellwien's opinions to the contrary, and I feel satisfied that it has been likewise admitted by Enderle in his recent description of the anthracolithic fauna of Balia Maaden in Asia Minor (Beiträge zur Geologie u. Palæont. Oesterreich-Ungarns, etc., vol. XIII, p. 63).

I have hitherto considered the *Productus* from the permian crag of Chitichun No. I as a variety of *P. boliviensis*, with which it agrees in its general characters, but I confess that the more complete specimens, which have been collected by v. Krafft in the exotic block No. 9 near Malla Sangcha, might probably better be interpreted as forming a distinct species and not a well-marked variety of *P. boliviensis*. In one of the ventral valves of these specimens a larger portion of the trail has been preserved than in any of my examples from Chitichun No. I. The trail exhibits a very peculiar sculpture. To the numerous and delicate longitudinal ribs are added a number of flat and broad costæ which impart to this portion of the shell a rugose character. This type of sculpture so decidedly differs from the ornamentation met with in the true *Prod. boliviensis* from South America and from Russia that the interpretation of my Himalayan *Productus* as a separate species appears to be the more correct course.

If we look at the illustrations of A. d'Orbigny's type-specimen of *Prod. boliviensis* from Yarbichambi, or at the Russian type-specimen of the species in Nikitin's memoir on the fauna of the Gshelian stage (Mémoires Com. géol. de la Russie, St. Pétersbourg, 1890, vol. V, No. 5, Pl. I, fig. 4), and compare them with that of *Prod. Chitichunensis* in this memoir, it must be admitted that a great difference is observable in their sculpture, greater even than between several species of the group of *semireticulati*, which have been distinguished by Waagen in the fauna of the Salt Range Productus limestone.

There is only one species of *Productus* in which the visceral region is ornamented by such numerous and delicate longitudinal striations as in *Prod. chitichunensis*. This species is *Prod. multistriatus*, Meek (U. S. Geol. Exploration of the 40th Parallel, vol. IV, pt. I, p. 76, Pl. VII, fig. 3). In its general outlines, in the presence of well-developed ears, in the shape of the mesial sinus and in the strong curvature of the profile of the umbonal region, my type-specimen of *Prod. chitichunensis* from Krafft's collections closely resembles *Prod. multistriatus*. Nevertheless, the two species must be placed among two different groups of the genus *Productus*, *P. multistriatus* being absolutely devoid of any transverse wrinkles in the apical region and belonging consequently to the section of "*lineati*," not of *semireticulati*.

The measurements of the figured specimen, the largest and most complete of *P. chitichunensis* hitherto discovered, are as follows :—

| | | |
|---|---|---|
| Length of the ventral valve in a straight line . . . . | 37 | mm. |
| " " " " valve along the curve . . . . | ca. 75 | " |
| Greatest breadth of the shell . . . . . . . | 72 | " |
| Thickness of the ventral valve . . . . . . | 29 | " |

*Number of specimens examined.*—4.

### PRODUCTUS GRATIOSUS, Waagen, Pl. III, fig. 23.

1884. *Productus gratiosus*, Waagen. Salt Range Fossils, Palæont. Indica, ser. XIII, vol. I, Productus Limestone Foss., p. 691, Pl. LXXII, figs. 3—7.

For a complete list of synonyms I refer the reader to my memoir on the fauna of Chitichun No. I (pt. 3 of this volume, p. 23). To these synonyms the following ought to be added :—

1900. *Productus gratiosus*, Schellwien, Die Fauna der Trogkofelschichten in den Karnischen Alpen und den Karawanken, Abhandl. K. K. Geol. Reichs-Anst., XVI Bd., p. 48, Taf. VIII, fig. 9.

1901. *Productus gratiosus*, Enderle. Ueber eine anthracolithische Fauna von Balia Maaden in Kleinasien, Beiträge zur Geol. und Palæontologie Oesterreich-Ungarns, etc., Bd. XIII, p. 66.

The present species of *Productus* is the commonest among A. von Krafft's collections. My specimens, although exhibiting great variability in size, inflation and sculpture, agree with the typical forms from the Salt Range and from Chitichun No. I. I have not met with a single specimen exhibiting the prominent ridges which mark off the wings from the remainder of the shell in *Prod. gratiosus* var. *occidentalis*, Schellw., from the carboniferous Fusulina limestone of Carinthia.

In some of my specimens the ventral valve is comparatively low, as in the types from the middle and upper Productus limestone of the Salt Range, which have been figured by Waagen in figs. 4 and 6 of Plate LXXII of his monograph.

In a few others the geniculation of the strongly inflated ventral valve is more distinctly marked than in the majority of specimens which have been illustrated by Waagen and by myself. The variability in the shape of the sinus is very great. A narrow mesial sinus is always present, though in some of my specimens it becomes rather shallow. In one of my specimens (Pl. III, fig. 23), however, the sinus is extraordinarily deep, deeper even than in the specimen represented in fig. 7 of my memoir on the fauna of Chitichun No. I.

As a rule the representatives of this species are easily distinguishable from the congeneric forms, notwithstanding their great variability. But in some of the delicately ribbed varieties the resemblance to *Prod. longispinus*, Sow., becomes so strong that a distinction is rendered difficult, if the wings, which in Sowerby's species are always less distinctly developed and smaller, are not accessible to examination.

*Number of specimens examined.*—34.

### PRODUCTUS cf. MONGOLICUS, Diener.

1883. *Productus cf. cora*, Kayser. Obercarbonische Fauna von Loping, Richthofen's "China," IV, p. 187, Pl. XXVII, fig. 5.

1897. *Productus mongolicus*, Diener. Himalayan Fossils, Palæont. Indica, ser. XV, vol. I, pt. 3, The permocarb. fauna of Chitichun No. I, p. 28, Pl. IV, figs. 8—10.

1899. *Productus mongolicus*, Diener, *Ibid.*, vol. I, pt. 4, Anthracolithic Fossils of Kashmir and Spiti, p. 88, Pl. V, figs. 7 and 8.

1901. *Productus mongolicus*, Fliegel, Ueber obercarbonische Faunen aus Ost- und Suedasien, Palæontographica, 48 Bd., p. 130.

A single, incomplete ventral valve is referred to this species with some hesitation. The apical region having been partly broken off, the specific determination cannot be made with certainty.

The triangular shape and the acuminate character of the apex forbid a closer comparison with *Productus undatus*, Defr., and its nearest allies. The wings have been broken off entirely. Thus the most important feature of distinction, between *Prod. mongolicus* and *P. compressus*, Waagen, is not observable. The ornamentation is more strongly marked than in *P. mytiloides*, Waag. The regular shape of the apical region and the absence of a distinctly marked geniculation, as represented in Waagen's illustrations of *P. compressus*, favour an identification of the present specimen with *P. mongolicus*.

My specimen is of small size, recalling in this respect the smaller of the two specimens, which have been figured in my memoir on the fauna of Chitichun No. I, and is considerably smaller than the types from the upper carboniferous rocks of Loping in China and from Barus in Kashmir.

### PRODUCTUS cf. UNDATUS, Defrance.

1842. *Productus undatus* (Defrance), L. de Koninck. Description des animaux fossiles du terrain carbonifère de Belgique, p. 156, Pl. XII, fig. 2.

For a more complete list of synonyms the reader is referred to my memoir on the Anthracolithic fossils of Kashmir and Spiti, pt. 2 of the present volume, p. 23.

An incomplete ventral valve is probably referable to this wide-spread species.

The shell is of moderate size and differs from the typical form of *Prod. undatus* as represented by L. de Koninck's and Davidson's type-specimens from the mountain limestone of Belgium, England and Ireland, by its elongately oval outline. Its length is nearly twice as great as its breadth. In this respect it recalls the specimens of *Productus cancriniformis*, Tschern., from the Productus shales of Kiunglung E. G., and from the permian rocks of the Gussass River, which have been illustrated in figs. 7 and 9 on Plate I of the fourth part of this volume. As, however, the shape of *Prod. cancriniformis* is exceedingly variable, every variation being found connecting the two extremes, *viz.*, those with elongately oval, and those with transverse, outlines, this difference between the shape of the present specimen and that of the commonest form of *P. undatus* can barely be considered to be of specific value.

The valve is strongly convex, without any sinus, but with a strongly incurved apex, which only just projects beyond the hinge-line. The hinge-line is considerably shorter than the greatest width of the shell and terminates in very small auricular expansions. The sculpture presents the "crumpled or terrace-shaped appearance," which is characteristic of *Prod. undatus* and its nearest allies. The concentric wrinkles are not regular but repeatedly interrupted in their course.

My specimen agrees perfectly with the typical *P. undatus* in its sculpture, but differs in its elongated outline and in the shape of the transverse profile, which is characterized by the lateral parts ascending very steeply from the margin towards the highly elevated visceral portion.

The wings are not bent down as steeply as the lateral parts, but are expanded in such a way as to form an angle with the adjoining portion of the valve. This character of the wings, only one of which has been preserved in my specimen, and the regularly rounded, uncompressed or acuminate shape of the apex, forbid an identification with similarly ornamented types of the section of "*striati*", such as *Prod. mongolicus*, *P. compressus* or *P. mytiloides*. Nor do I believe the relations of my specimen to *Prod. hæmisphærium*, Kutorga, ought to be considered as closer than to *P. undatus*.

My specimen is absolutely devoid of spines, and the terrace-shaped appearance is far more strongly marked than in *P. hæmisphærium*, in consequence of its better developed concentric wrinkles.

Exact measurements of this specimen cannot be given on account of its incomplete state of preservation.

### PRODUCTUS PLANO-HÆMISPHÆRIUM, Netsch., Pl. III, fig. 17.

1854. ***Productus hæmisphærium***, **Keyserling, in Schrenck's Reise nach dem Nordosten des europæischen Russlands. II. p. 102, Taf. II. figs. 16, 17.**

1861. *Productus hæmisphærium*, (*ex parte*) Geinitz. Die Dyas, Bd. I, p. 102, Taf. XVIII, fig. 29 (*non* 28).

1894. *Productus plano-hæmisphærium*, Netschajew. Die Fauna der permischen Ablagerungen des oestlichen Theiles des europæischen Russlands, Mém. of the Imper. University of Kasan, T. XXVII, pt. 4, p. 148, Pl. IV, fig. 2.

N. Golowkinsky was the first palæontologist to remark the difference between the permian species which had been collected by L. v. Schrenck in the limestone-marl of the Pinega from the typical *Productus hæmisphærium*, Kutorga. The characters by which it differs have been clearly fixed by Netschajew, who assigned a new specific denomination to Graf Keyserling's species. This remarkable species, which has hitherto never been noticed in deposits lower than true permian, is represented in A. v. Krafft's collections by two ventral valves, one of them agreeing perfectly with Netschajew's description and with the figure given by Count Keyserling.

My figured specimen is smaller than those illustrated by the Russian authors; it has a transversely elongate outline and very strongly curved profile.

The beak is strongly incurved and almost spirally inrolled. The wings are strongly produced and fusiform, but not marked off distinctly from the visceral portion of the valve. On the contrary, the transverse section of the valve from the central part, which is the highest, to the extremities of the wings, forms an almost regular semicircle, with a flat depression in the middle. To this depression, however, there is no corresponding sinus in the front-margin. The hinge-line is provided with a small number of little, but distinctly developed, spines.

The surface of the shell is covered with numerous radiating, longitudinal lines, which are separated by valleys of equal width. Their longitudinal ornamentation is interrupted by irregular transverse wrinkles, which are broader and more prominent than the radiating lines. The sculpture is as distinctly developed in my Himalayan specimen as in Keyserling's example from the Pinega, and more strongly marked than in Netschajew's type-specimen from the river Wiatka.

The trail has not been preserved in any of my examples.

The measurements of the figured specimen are as follows:—

| | |
|---|---|
| Length of the shell in a straight line . . . . . | 8·5 mm. |
| „ „ „ along the curve . . . . . | 17 „ |
| Breadth of the shell along the hinge-line . . . | 16 „ |
| Thickness of the ventral valve . . . . . | 7 „ |

*Number of specimens examined.*—2.

*Remarks.*—An Asiatic species, which seems to be nearly allied to the present one, is ***Productus yuennanensis***, Lóczy (Wissenschaftliche Ergebnisse der Reise des Grafen Bela Szechenji in Ostasien III, Bd. IV, Abth., p. 125, Taf. VI, figs. 1, 2), from the upper carboniferous and permocarboniferous limestone of the Wo-shi-wo grotto near Young-chang-fu in Yunnan. This Chinese species strongly recalls ***Prod. plano-hæmisphærium*** in its shape and sculpture, especially the smaller specimen, which is represented in fig. 18 together with the text of Lóczy's description. It differs chiefly by the presence of a well-marked angle, in which the strongly produced and fusiform wings unite with the visceral portion of the ventral valve.

The variety of ***Productus giganteus***, Mart., which has been elevated to the rank of a species—***Prod. latissimus***—by Sowerby, also shows a well-marked external resemblance to ***Prod. plano-hæmisphærium*** in its outlines, especially in the presence of strongly produced wings, which are not marked off from the remainder of the valve, and in the shape of the profile, but differs remarkably in its sculpture, which consists of irregular longitudinal ribs with scattered tubercles, and in the absence of spines along the hinge-line.

### MARGINIFERA TYPICA, Waagen.

1884. *Marginifera typica*, Waagen. Salt Range Fossils, Palæont. Indica, ser. XIII, vol. I, Productus Limestone Foss., p. 717, Pl. LXXVI, figs. 4—7; Pl. LXVIII, fig. 1.
1889. *Marginifera typica*, Tschernyschew. Mém. Com. géol. St. Pétersbourg, vol. III, No. 4, p. 374, Pl. VII, figs. 22—28.
1897. *Marginifera typica*, Diener. Himalayan Fossils, Palæont. Indica, ser. XV, vol. I, pt. 3, The permocarb. fauna of Chitichun No. I, p. 32, Pl. IV, figs. 11—13; Pl. V, figs. 1—2.

Among the representatives of Waagen's sub-genus *Marginifera* in A. v. Krafft's collections two ventral valves agree perfectly with my specimens from the permian limestone of Chitichun No. I. In one of them the internal ridges,—to which a generic or at least sub-generic value has been attributed by Waagen, Tschernyschew and myself, notwithstanding Nikitin's and Schellwien's arguments to the contrary,—are distinctly developed.

### MARGINIFERA HELICA, Abich, Pl. III, fig. 9.

1878. *Productus intermedius helicus*, Abich. Geologische Forschungen in den Kaukasischen Laendern. I, Theil, Eine Bergkalkfauna aus der Araxesenge bei Djulfa in Armenien, p. 44, Taf. X, figs. 3, 4, 13—20.
1878. *Productus aculeatus*, Abich. *Ibidem*, p. 50, Taf. V, fig. 12, Taf. X, fig. 21.
1878. *Productus spinulosus*, Abich. *Ibidem*, p. 51, Taf. V, fig. 9.
1879. *Productus horridus* var. *minor*, Val. v. Möller. Ueber die bathrologische Stellung der Djulfa-Schichten, Neues Jahrb. f. Miner., p. 233.
1887. *Marginifera helica*, Waagen. Salt Range Fossils, Palæont. Indica, ser. XIII, Vol. I, Productus Limestone Fossils, p. 714.

1900. *Marginifera intermedia helica*, G. v. Arthaber. Ueber das Palaeozoicum in Hocharmenien und Persien Beiträge zur Geol. u. Palaeont. Oesterr.-Ungarns, etc., Bd. XII, p. 265, Taf. XX, figs. 10—12.

Of this species one single but excellently preserved specimen has been discovered in A. v. Krafft's Himalayan collection. It is unquestionably identical with the Armenian shell which was first described by Abich and the characters of which have been more clearly established by G. von Arthaber in his recently published memoir on the permian fauna of Djulfa.

It has been stated by G. von Arthaber that ***Marginifera helica*** and ***M. spinosocostata***, Abich, are the terminal links of a chain of forms which are connected by so many intermediate shapes that their exact determination becomes sometimes very difficult. It is not, however, to any of the intermediate shapes but to the typical ***M. helica*** that the present specimen must be compared. Among the types illustrated by Abich the specimens represented on Pl. X, in figs. 12 and 17 are most in accordance with my Himalayan example.

My specimen is of small size, with a transversely oval outline and small wings, which are not marked off sharply from the remainder of the shell. The ventral valve is strongly inflated and provided with a shallow sinus, which becomes somewhat more distinctly developed in the vicinity of the front.

The hinge-line is considerably shorter than the greatest diameter of the shell, and its corners are truncated. In the apical region the valve takes a remarkably acuminate appearance. The beak is small and pointed, and projects beyond the hinge-line. Its point is perfectly well preserved and exactly agrees with the illustration given by G. v. Arthaber in fig. 12 of his memoir.

The shell is ornamented with a very delicate concentric or transverse striation, which is most distinctly marked in the apical region. The tubercles are not numerous and are quite irregularly arranged.

The dorsal valve is flatly concave, with a deep impression directly below the apex. The small wings are slightly reflected and separated from the remainder of the valve by two shallow, rounded ridges. A very low and delicate fold corresponds to the median line of the valve. The margins exhibit the bordering ridges, which are a leading feature of Waagen's sub-genus ***Marginifera***.

The sculpture of this valve consists of very numerous and delicate concentric lines, which are occasionally interrupted by low spines.

No trace of a trail has been noticed in this specimen. In this respect the latter also perfectly agrees with the Armenian types collected by Frech and G. v. Arthaber, none of which is provided with a trail.

The measurements of the present specimen are as follows :—

| | | |
|---|---|---|
| Length of the shell in a straight line . . . . | 15 | mm. |
| ,, ,, ,, along the curve . . . . . | 26 | ,, |
| Length of the dorsal valve . . . . . . | 12 | ,, |
| ,, ,, hinge-line . . . . . . | 11·5 | ,, |
| Breadth of the shell . . . . . | 19 | ,, |
| Thickness of both valves . . . . . . | 10 | ,, |

*Number of specimens examined.*—1.

*Remarks.*—The identification of a Himalayan *Marginifera* with Abich's species is of some interest, as the latter has not as yet been discovered in any beds but the permian cephalopod-bearing limestone of Djulfa.

From *Marginifera transversa*, Waagen, a Salt Range species which is considered to be most nearly allied to *M. helica* by Waagen, the present specimen is distinguished at a glance by the absence of the regular row of spines, which gives its characteristic appearance to the limit between the wings and the visceral portion of the ventral valve in *M. transversa.*

Some of the Chinese specimens, which have been identified with *Productus aculeatus*, Mart., by Kayser (Obercarbonische Fauna von Loping, Richthofen's "China," IV Bd., Taf. XXVI, fig. 1, *non* 2-5), are referred to a new variety of *Marginifera helica* by Fliegel (Palæontographica, 48 Bd., p. 129, Taf. VI, fig. 7). But they do not agree completely with any of Abich's Armenian examples, as has been stated by Fliegel himself. To the differences which have been enumerated by that author the presence of a very distinct radial or longitudinal ribbing in the Chinese shells must be added, which I have not noticed in any of the numerous specimens of the true *M. helica* which have been collected in the permian Otoceras beds of Djulfa by Frech and G. v. Arthaber.

### SCACCHINELLA, sp. ind., Pl, III, fig, 10.

1896. *Scacchinella*, Gemmellaro. Sopra due nuovi generi di Brachiopodi, provenienti dei calcari con Fusulina della provincia di Palermo, Palermo, p. 4.

It is with some doubt that I refer an incomplete fragment of a ventral valve to the genus *Scacchinella*, without venturing on any specific determination.

Only the apical region is at all well preserved in this fragment. Its outlines are irregularly triangular. The very long and prominent apex is not incurved, but considerably deformed. It is not distinctly pointed but shows a mark of attachment, as if it had been fixed to a foreign body. The hinge-line is straight and considerably shorter than the greatest breadth of the shell. The ventral valve is provided with a very high, triangular area which is separated from the lateral parts by sharply rounded edges. A narrow pseudodeltidium is only indistinctly developed.

I have not been able to clear its surface from the adhering matrix, and consequently cannot say whether in its ornamentation it does or does not correspond to the adjoining portions of the area, in which both horizontal and vertical striæ are noticed.

The surface of the ventral valve is covered with very numerous and delicate concentric lines of growth. Where the shelly substance has been entirely preserved, very delicate and long tubular spines may be noticed.

No exact measurements can be given, owing to the fragmentary and deformed condition of the present specimen.

There are three genera, to which our form may be compared, *Scacchinella*, Gemmellaro, *Aulosteges*, Helmersen, and *Geyerella*, Schellwien. All these genera are characterised by the presence of a strongly elongated apical portion of the ventral valve, which occasionally assumes the character of a true proboscis and imparts to the valve a conical shape.

*Geyerella* is not difficult to distinguish from my specimen by its radial plication and by the presence of a very distinctly marked pseudodeltidium. The latter character may likewise be considered as a feature of distinction between our form and the genus *Aulosteges*. The ornamentation of the shell is also different. Among the genera which the present specimen recalls in its external characters—nothing of the internal arrangement is, unfortunately, known to me—*Scacchinella* is the one to which it appears to be most nearly allied. A comparison of the illustrations of the Himalayan specimen and of *Scacchinella variabilis* in Gemmellaro's memoir will convince the reader of the great external resemblance of the two species. Gemmellaro's Sicilian representatives are, it is true, devoid of the silky lustre of the shelly substance, which is distinctly exhibited in my Himalayan example, but the presence of this character depends only on the state of preservation of the shell, as has been stated by Schellwien (Die Fauna der Trogkofelschichten in den Karnischen Alpen und den Karawanken, Abhandl. K. K. Geol., Reichs-Anst., XVI Bd., p. 33).

It is on the strength of the external resemblance of my Himalayan specimen to *Scacchinella* that I have referred it to that genus, but I am far from being convinced of the correctness of this identification.

### LYTTONIA cf. NOBILIS, Waagen.

1883. *Lyttonia nobilis*, Waagen. Palæontologia Indica, ser. XIII, Salt Range Fossils, vol. I, Productus Limestone Fossils, p. 398, Pl. XXIX, XXX, figs. 1, 2, 5, 6, 8, 10, 11.

1897. *Lyttonia nobilis*, Diener. The permocarb. fauna of Chitichun No. I, Palæont. Indica, ser. XV, Himalayan Fossils, vol. I, pt. 3, p. 87, Pl. I, figs. 5—7.

Among the fossil materials collected by A. v. Krafft there is a fragment of a moderately large *Lyttonia* which I believe to be most probably identical with Waagen's species from the Productus Limestone of the Salt Range and of the permian limestone of Chitichun No. I.

My Himalayan fragment corresponds to the cardinal portion of the ventral valve, but its outlines are broken off entirely. On the inner side of the ventral valve the median longitudinal furrow is clearly exhibited. The high lateral septa form roof-shaped ridges and are placed symmetrically to the median furrow, which is partly filled up with matrix, so as to cover almost completely the low but indistinctly developed median septum. The lateral septa are placed symmetrically to the median furrow and are separated by valleys of equal breadth.

Of the shelly substance no trace has been preserved.

The very close relationship of *Lyttonia nobilis* and *L. tenuis*, Waagen, makes a distinction between the two species nearly impossible, if one has to deal with imperfect fragments only. It is chiefly the massive development of the lateral septa, which induced me to venture on an identification of my Himalayan specimen with *L. nobilis*.

### ORTHOTHETES KRAFFTI, nov. sp., Pl. III, figs. 6—7.

There has been some confusion about the distinction of genera among Waagen's sub-family of *Orthothetinæ*; this, however, has been cleared up recently by Schellwien in his monograph on the permocarboniferous Brachiopoda of the Karawankas and Carnian Alps (Abhandl. K. K. Geol. Reichs-Anst., XVI Bd., p. 15). Nothing seems to be more difficult than to classify those fossil shells, which in their external characters so closely resemble each other, and the majority of which have been referred to *Streptorhynchus* (recte *Orthothetes*) *crenistria*, Phill., by a large number of authors.

Schellwien's classification, which in its principles follows the scheme given by Waagen, is chiefly based on the internal arrangement. In this classification the sub-family of *Orthothetinæ* comprises five genera, which are distinguished by the following characters:—

1. *Streptorhynchus*, King (Monograph of the permian Fossils of England, p. 109). Without any distinct septa in the ventral valve. Very variable in shape and sculpture.

2. *Derbyia*, Waagen (Salt Range Fossils, Palæontologia Indica, ser. XIII, vol. I, Productus Limestone Foss., p. 591). Median septum in the ventral valve. Shell smooth or nearly smooth; not very high.

3. *Orthothetes*, Fischer v. Waldheim (Oryctographie du Gouv. de Moscou, 1830, p. 133). Ventral valve with two septa, which are strongly divergent in geologically older forms, but run nearly parallel in geologically younger species (sub-genus *Orthothetina*, Schellwien, Neues Jahrb. f. Miner., 1900, I, p. 8). Recalling *Derbyia* in its external characters. Hinge-line long; dorsal valve with a distinct area.

4. *Meekella*, White and St. John (Transact. Chicago Acad. of Sciences, 1856, I, p. 120). Ventral valve with two generally parallel septa, which in some species approach each other so closely that they may be mistaken for a single septum. Hinge-line shorter than the greatest breadth of the shell. The majority of species with strong radiating plications. Valves high, the dorsal one not provided with an area.

5. *Geyerella*, Schellwien (Abhandl. K. K. Geol. Reichs-Anst., XVI, Bd., p. 24). The two septa of the ventral valve are united into a single median septum within the visceral portion of the shell. In shape and sculpture agreeing with *Meekella*, but the hinge-line as a rule more or less obtusely rounded and not distinctly limited off from the lateral margins.

The present species, which in A. von Krafft's collections is represented by two tolerably well preserved examples, somewhat recalls in its size, outlines and ornamentation the small variety of *Orthothetes crenistria*, Phill., which has been illustrated by Davidson on Pl. XXVI, fig. 4, of his monograph (*Orthis caduca*, M'Coy). The internal characters of the species are those of the genera *Meekella* and *Orthothetes*. Through the translucent shell of the better preserved specimen the septa are clearly visible, at least in the apical region. In the ventral valve two parallel septa can be noticed, reaching from the apex for some distance towards the visceral portion of the shell, where they are no longer observable. In the apical region of the dorsal valve the presence of a median septum and of two strongly diverging lateral septa has been ascertained. As the permian species of *Orthothetes* with parallel septa in the ventral valve completely agree with *Meekella* in their internal arrangement, a decision as to which of the two genera should include our species must be based on external characters.

The external features are of a somewhat conflicting character. According to Schellwien's statement even those species of *Meekella* in which the radial plication is but very indistinctly developed, can always be distinguished from *Orthothetes* by their short hinge-line and by the absence of an area in the dorsal valve. In these characters the present species agrees with *Meekella*, not with *Orthothetes*. It is, however, evident that the overrating of this character would lead us to a result which is contradictory to the majority of characters in our species. In all its external features the latter bears so close a resemblance to a typical *Orthothetes*, and not to *Meekella*, that it cannot be excluded from the first genus simply on account of its short hinge-line. By the absence of radial plications and by its low area the present species is rather distant from the typical representatives of the genus *Meekella*. Even the group of *Meekella evanescens*, Schellwien, in which radial plications are only rudimentary, is at once distinguished by the disproportionate size of its two valves and by the extremely high area of its ventral valve.

Thus our Himalayan species cannot be classed with *Meekella*, notwithstanding its short hinge-line, but must be placed in the genus *Orthothetes*, Fischer v. Waldheim.

My specimens are of moderate size, with a comparatively low ventral valve, a low ventral area and a very short hinge-line, which is not limited off very distinctly from the lateral margins. In the longitudinal direction the ventral valve is barely arched at all, while transversely it is strongly curved in the vicinity of the lateral margins, but appears nearly flattened in the middle. The beak is prominent, pointed, and very slightly incurved. The triangular area is not high, reclining, and provided with a comparatively small pseudodeltidium. A shallow median sinus is noticed in the front-margin.

The dorsal valve is but little shorter than the ventral, and more strongly vaulted. From the apex a median depression extends to the front. This median depression is bordered on each side by a low, rounded elevation, which gradually passes into the lateral portions of the shell. The apex projects distinctly beyond the hinge-line. The area of this valve, if it exists, is only linear.

Both valves are covered by a delicate but sharp radial striation, which increases towards the margins of the valves by the intercalation of new ribs. Where the shelly substance has been entirely preserved, very fine concentric striæ of growth may be observed intersecting the radiating ornamentation. Radial plications are only quite indistinctly developed in the vicinity of the lateral margins.

The measurements of the more completely preserved specimen are as follows:—

| | |
|---|---|
| Entire length of the shell | 19·5 mm. |
| Length of the dorsal valve | 18 „ |
| Entire breadth of the shell | 23 „ |
| Length of the hinge-line | 18 „ |
| Thickness of both valves | 9·5 „ |

*Number of specimens examined.*—2.

*Remarks.*—*Orthothetes Kraffti* belongs to a group of forms which differs from the typical species of the genus by its short hinge-line.

In L. v. Lóczy's descriptions of the carboniferous fauna of Teng-tian-ching in the Chinese province of Kansu (Wissenschaftl. Ergebnisse der Reise des Grafen Béla Széchenyi in Ostasien III, Bd. IV., Abth. p. 86, Taf. I, figs. 25–27) a shell has been figured under the designation of *Orthothetes crenistria* var. *minor*, which seems to be most nearly allied to the present species. The only remarkable difference consists in the extreme flatness of the dorsal valve. Whether this valve is or is not provided with an area, cannot be made out from the illustration.

*Orthothetes semiplanus*, Waagen (Salt Range Fossils, Palæont. Indica, ser. XIII, vol. I, Productus Limestone Foss., p. 608, Pl. LV, figs. 1, 2), which agrees with the present species in general outlines, is easily distinguished from the latter by its perfectly flat dorsal valve. In this respect it approaches Lóczy's Chinese species from the carboniferous rocks of Kansu.

### SPIRIFERINA cf. OCTOPLICATA var. FASTIGATA, Schellwien, Pl. III, fig. 11.

1860. *Spiriferina cristata* var. *fastigata*, Schellwien. Die Fauna der Trogkofelschichten in den Karnischen Alpen und den Karawanken, Abhandl. K. K. Geol. Reichs-Anst., XVI, Bd., p. 66, Taf. XI, figs. 1—3.

There is only one incomplete ventral valve of a *Spiriferina* present in A. von Krafft's collection. It might be attributed with nearly equal right to either *Spiriferina octoplicata* var. *fastigata* or to *Spiriferina Margaritæ* var. *consanguinea*, Gemm. It is chiefly on account of its strongly transverse shape that I prefer to identify it provisionally with the first-named species. It is provided with a very broad and angular sinus, which is more strongly produced towards the front than in any of my examples from the permian limestone of Chitichun No. I. In the shape of the sinus it almost recalls *Spiriferina Panderi*, v. Mœller, from the upper carboniferous rocks of the Ural Mountains in which, however, the sinus is not angular, but flatly depressed or provided with a low elevation along its median line.

*Number of specimens examined.*—1.

### SPIRIFER WYNNEI, Waagen.

1883. *Spirifer Wynnei*, Waagen. Salt Range Fossils, Palæontologia Indica, ser. XIII, vol. I, Productus Limestone Fossils, p. 517, Pl. XLIV, figs. 6, 7.

1889. *Spirifer Wynnei* (?), Tschernyschew. Mém. Com. géol. St. Pétersbourg, III, No. 4, p. 271, Pl. V, figs. 7, 8.

1897. *Spirifer Wynnei*, Diener. Palæontologia Indica, ser. XV, Himalayan Foss., vol. I, pt. 3. The permo-carb. fauna of Chitichun No. I, p. 44, Pl. VII, figs. 1—4.

1899. *Spirifer siculus*, Gemmellaro. La fauna dei calcari con Fusulina della valle del F. Sosio, Fasc. IV, pt. 1, p. 296, Taf. XXXVI, figs. 1—6.

1900. *Spirifer Wynnei*, Schellwien. Die Fauna der Trogkofelschichten in der Karnischen Alpen und den Karawanken, Abhandl. K. K. Geol. Reichs-Anst., XVI, Bd., p. 75, Taf. X, figs. 5, 6.

Of this species, one of the leading fossils in the permian limestone of Chitichun No. I, several examples have been found in A. v. Krafft's collections. They agree in every respect with my specimens from Chitichun No. I, though none of them reaches the large size of the type illustrated on Pl. VI, fig. 1. All my specimens exhibit the characteristic ornamentation, the low median fold in the dorsal, and the high reclining area in the ventral, valve, which have been noticed by Waagen as peculiar features in his Punjab examples.

The sinus, which, as a rule, is rather broad and shallow, is divided off sharply from the lateral parts of the ventral valve. It forms a triangular area, which increases considerably in width towards the front. This shape of the sinus is clearly developed both in the Alpine and Himalayan types of *Sp. Wynnei*, but is less distinctly marked in Waagen's types from the Salt Range.

Prof. Schellwien is disposed to unite with this species *Spirifer siculus*, a name proposed by Gemmellaro for his specimens from the permian Fusulina limestone of Sicily. Prof. Gemmellaro states that *Sp. siculus*, although recalling *Sp. Wynnei* in the shape of its area and in its ornamentation, differs from it in its general outlines, in the shape of its apex, sinus and median fold of the dorsal valve. From this view I am obliged to dissent. Gemmellaro's illustrations of *Sp. siculus* represent a type which agrees exactly with the Himalayan variety of *Sp. Wynnei*. The character of the sinus, especially, is absolutely identical in both species. I therefore fully agree with Schellwien and Frech in their opinion that *Spirifer siculus* must be placed among the synonyms of *Sp. Wynnei*.

*Number of specimens examined.*—5.

### SPIRIFER TIBETANUS, Diener.

1897. *Spirifer tibetanus*, Diener, The permocarbon. fauna of Chitichun No. 1, Palæont. Indica, ser. XV, Himalayan Fossils, vol. I, pt. 3, p. 45, Pl. VI, figs. 1—7.

Of this characteristic species a single incomplete ventral valve has been met with in A. v. Krafft's collections. It is, however, sufficiently well preserved to permit of certain identification.

### SPIRIFER FASCIGER, Keyserling.

1877. *Spirifer fasciger*. Keyserling. Wissenschaftliche Beobachtungen auf einer Reise in das Petschoraland, p. 231, Taf. VIII, fig. 3.

1862. *Spirifer musakheylensis*, Davidson. Quart. Journ. Geol. Soc., XVIII, p. 28, Pl. II, fig. 2.

To the list of synonyms given in pt. 2, p. 63, and pt. 4, p. 35, of the present volume the following ought to be added :—

1889. *Spirifer fasciger*, Tschernyschew. Mém. Com. Géol. St. Pétersbourg, vol. III, No. 4, p. 366, Pl. V, fig. 4.

1892. *Spirifer fasciger*, Schellwien. Die Fauna des Karnischen Fusulinenkalkes, Palæontographica, Bd. XXXIX, p. 42, Taf. V, figs. 2, 3.

1898. *Spirifer fasciger*, Stuckenberg. Mém. Com. Géol. St. Pétersbourg, vol. XVI, No. 1, p. 342.

1900. *Spirifer fasciger*, Schellwien. Die Fauna der Trogkofelschichten in den Karnischen Alpen und den Karawanken, Abhandl. K. K. Geol. Reichs-Anst., Bd. XVI, p. 70, Taf. X, figs. 1—4.

When publishing my descriptions of *Spirifer musakheylensis* in my monographs on "Himalayan Fossils", I expressed the opinion that *Spirifer musakheylensis*.

*Sp. fasciger* and *Sp. tegulatus* ought to be considered as specifically different, notwithstanding Tschernyschew's and Schellwien's statements to the contrary. Since then, thanks to the kindness of my distinguished friend Prof. Tschernyschew, I have had the opportunity of studying numerous specimens of *Sp. fasciger*, which belong to the beautiful collections of the Russian Geological Survey in St. Petersburg. This examination convinced me of the fact that *Spirifer musakheylensis* and *Sp. tegulatus* are not sufficiently distinct to be retained as separate species, but are all modifications of a single, very variable species, for which Count Keyserling's original name, *Spirifer fasciger*, must be retained. To this view, which has been based on additional information obtained since concluding my memoir on the anthracolithic fossils of Kashmir and Spiti (pt. 2 of the present volume), I have alluded in a subsequent memoir (Die Aequivalente der Carbon und Permformation im Himalaya", Sitzungsber. Kais. Akad. d. Wissensch. Wien, math. nat., Cl. Bd. CVI, 1897, p. 449).

In the permian limestone of Chitichun No. I, *Spirifer fasciger* is exceedingly rare. One single incomplete example of this species, elsewhere a leading one in the permian rocks of the Himalayas, has been noticed. In the crag No. 9 near Malla Sangcha *Sp. fasciger* is a little more richly represented. All the specimens collected by A. v. Krafft are of small size and provided with folds corresponding to the bundles of ribs, which are rounded, and not sharply edged. In none of them is the lamellose character of the striæ of growth developed, the presence of which is the most important point of difference between *Sp. fasciger* and its American representative, *Sp. cameratus*, Morton.

Much difference of opinion has been expressed as to the specific value of *Spirifer cameratus* and its allies, such as *Sp. condor*, d' Orb., and certainly some of the American types which have been illustrated by Hall and Clarke (Introduction to the Study of the Genera of Fossil Brachiopoda, Palæontology of New York, vol. VIII, pt. 2, 1894, Pl. XXXII, figs. 9—15) and by Beede (Variations of the external appearance and internal characters of *Spirifer cameratus*, Kansas University Quarterly, 1898, vol. VII, No. 2) so closely resemble the variety of *Sp. fasciger* without a lamellose sculpture, that I should really be at a loss to distinguish them. But not having hitherto been able to examine personally a typical example of *Spirifer cameratus*, I cannot comment upon its specific claims.

*Number of specimens examined.*—3.

### SPIRIFER sp. ind. ex aff. SP. MARCOUI, Waagen, Pl. III, fig. 21.

A single but complete ventral valve strongly recalls this Salt Range species, with which, however, it is certainly not identical.

The present valve is transversely elongated with rounded-off corners and almost equally curved in both directions. The hinge-line is a little shorter than the greatest width of the shell. The area is broad, distinctly concave and provided with an equilateral, triangular fissure. The apex is strongly attenuated and terminates in a small and gracefully pointed beak. A sharply impressed sinus, originating in the apex, forms a triangular area, which increases considerably in width towards the front, where it is distinctly produced. It is separated from the lateral parts of the valve by obtusely rounded edges, and is rounded at its base.

The radial striation is much coarser than in *Spirifer Wynnei*. There are about twelve ribs within the sinus and 20 on each lateral part of the valve. The ribs are mostly simple, very rarely dichotomous. No traces of fasciculi are noticed. The radiating sculpture is crossed by strong, imbricating striæ of growth in the vicinity of the front-line.

The measurements of this specimen are as follows:—

| | |
|---|---|
| Entire length of the shell | 30 mm. |
| „ . breadth „ „ „ | 39 „ |
| Thickness of the ventral valve | 13 „ |
| Height of the area | 8·5 „ |
| Length of the hinge-line | 36 „ |

This species is certainly nearly allied to a species from the Artinskian stage, which has been referred with some reserve to *Spirifer Marcoui*, Waagen, by Tschernyschew (Mém. Com. géol. de la Russie, St. Pétersbourg, 1889, vol. III, No. 4, p. 367, Pl. V, fig. 5). Both species, being represented by ventral valves only, are probably identical. They agree in all their characters of specific importance, namely, in the presence of a high and concave area, in the graceful shape of the small beak, and in their triangular sinus, which is distinctly separated from the lateral portions, as in *Sp. Wynnei*, and not impressed in the middle.

It is chiefly this shape of the sinus, which differs, in my Himalayan and in Tschernyschew's Artinskian specimen, from Waagen's Punjab types. In the latter the sinus is not marked off from the remainder of the shell, but very sharply impressed in the middle. The latter character is a little less distinctly developed in the example of *Spirifer striatus*, Marcou (Geology of North America, Zurich, 1858, p. 49, Pl. VII, figs. 2—2*a*), which has been considered as the prototype of *Sp. Marcoui* by Waagen. *Spirifer Marcoui* from Pecos village differs from the present specimen by its more closely arranged ribs and by its narrower sinus, which is less strongly expanded in the vicinity of the front.

A species which appears also to be closely allied to the present one is *Spirifer Logani*, Hall (Palæontology of Iowa, vol. I, pt. 2, p. 647, Pl. XX, fig. 7; Pl. XXI, figs. 1, 2), one of the American representatives of the group of *Spirifer striatus* from the carboniferous Keokuk limestone of Illinois. Both species chiefly agree in the presence of a "broad, mesial sinus, which in the middle of the shell occupies fully one-third of the width, sloping abruptly to the cardinal extremities, and extremely produced and elevated in front in a sub-triangular extension." The pattern of ornamentation is also the same in both species, the ribs being coarser and fewer than in shells of *Spirifer striatus* of the same size. A closer comparison of my Himalayan specimen with *Sp. Logani* is, however, not possible without the dorsal valve being available for examination, which in *Sp. Logani* is enormously inflated and provided with a very prominent and subangular mesial fold.

Another species which agrees with my Himalayan specimen in the entire absence of fasciculation of the ribs and in the presence of lamellose striæ of growth is *Spirifer condor*, d' Orbigny (Voyage dans l' Amérique Méridionale, T. III, pt. IV, Paléontologie, Paris 1842, p. 46, Pl. V, figs. 11—14), from the carboniferous rocks of Yarbichambi in Bolivia. It differs, however, from *Sp. condor* by its sharply rounded, but not attenuated, cardinal edges and by the peculiar shape of its sinus which is considerably wider and strongly produced in the vicinity of the front.

From *Spirifer striatus*, Mart., the present species is distinguished by its coarser ribs and by its lamellose sculpture. That it belongs to the group of *Sp. striatus* cannot be questioned, but its exact position within this group is as yet doubtful.

### MARTINIA ACUTOMARGINALIS, Diener, Pl. III, fig. 22.

1897. *Martinia acutomarginalis*, Diener. The permocarb. fauna of Chitichun No. I, Palæontologia Indica, ser. XV, Himalayan Foss., vol. I, pt. 3, p. 55, Pl. VIII, figs. 3, 4.

1899. *Martinia Semiramis*, Gemmellaro. La fauna dei calcari con Fusulina della Valle del F. Sosio, Fasc. IV, pt. I, p. 311, Pl. XXXI, figs. 26—35.

1899. *Martinia* ex aff. *M. semiplana*, Semper, Neues Jahrb. f. Miner., etc., 1899, I, p. 248, Taf. XVI, fig. 20.

Several specimens of *Martinia*, one of them perfectly well preserved, are referable to this characteristic and easily recognised species. They agree very well with the figures and description which have been given in my memoir on the fauna of Chitichun No. I. One example is of comparatively large size, measuring 17 mm. in length and 15·5 mm. in breadth. The other specimens are considerably smaller. The measurements of a fairly complete one are as follows :—

| | |
|---|---|
| Entire length of the shell | 11·5 mm. |
| „ breadth „ „ „ | 11·5 „ |
| Length of the dorsal valve | 9·5 „ |
| „ „ „ hinge-line | 6 „ |
| Thickness of both valves | 7·5 „ |

*Number of specimens examined.*—5.

*Remarks.*—In 1899 Gemmellaro described and figured a small *Martinia* from the permian Fusulina limestone of Sicily under the name of *Martinia Semiramis*. Frech (Die Dyas, Lethæa palæozoica, II Bd., 3 Lfg., p. 501) places *M. Semiramis* among the synonyms of the present species, an opinion with which I entirely agree. When describing his Sicilian species, Gemmellaro was probably not acquainted with my description of *M. acutomarginalis* in my memoir on the permian fauna of Chitichun No. I. Otherwise he would not have failed to refer to the remarkable similarity of the two forms. If we compare the illustrations of my Himalayan specimens of *M. acutomarginalis* with the types of *M. Semiramis*, of which the woodcuts (figs. 32—34) in Gemmellaro's memoir are faithful representations, the absence of distinctive features will be obvious. To me the two species appear absolutely indistinguishable. Nor have I been able to find out any characters of distinction between them from Prof. Gemmellaro's descriptions.

M. Semper (l.c., p. 253) is of opinion that *M. Cornelia*, Gemmellaro (l.c., p. 314 Pl. XXXI, figs. 19—25), should also be placed among the synonyms of *M. Semiramis*. There is little doubt as to the intimate resemblance existing between the two shells. But not having had the opportunity of examining a series of both, I prefer for the present to let the question of their identity remain open.

### MARTINIA ELEGANS, Diener.

1897. *Martinia elegans*, Diener. The permocarb. fauna of Chitichun No. I, Palæont. Indica, ser. XV, Himalayan Foss., vol. I, pt. 3, p. 54, Pl. VIII, figs. 1, 2; Pl. IX, figs. 1, 2.

1899. *Martinia Distefanoi*, Gemmellaro. La fauna dei calcari con Fusulina della Valle del F. Sosio, Fasc. IV, Pl. I, p. 306, Pl. XXX, figs. 14—22.

This large species, recalling the group of *Martinia Warthi*, Waag., by the development of little auricular expansions on both sides of the short hinge-line, is represented by a small number of ventral valves in A. v. Krafft's collections. One specimen has the surface of the shell partly preserved. Besides the numerous irregularly clustered granulations and impressions, which have been noticed in the description of the Chitichun types, traces of very short and delicate spines are occasionally found.

In 1899 Gemmellaro described and figured a large *Martinia* from the permian Fusulina limestone of Sicily under the name of *M. Distefanoi*. He states that his species, though being most intimately allied to *M. elegans*, seems to be distinguished from the Himalayan form by certain characters which preclude their identification. These characters are the following, according to Gemmellaro: "The Sicilian species is as a rule more elongate and compressed, the disproportion in the inflation of its two valves is less considerable. Its apical region is less strongly inflated and incurved, its hinge-line is shorter, measuring a little less than one-half of the entire breadth of the shell. Its surface is covered with the impressions of little spines, whereas it is supposed to be smooth in *M. elegans*."

Apart from the fact that most of these characters are of so small importance as to be of little use for specific distinction, I cannot admit that in all the examples of *Martinia elegans* which have come under my observation the valves were more unequally vaulted, the beaks more strongly inflated and incurved and the hinge-lines longer than is the case in the types of *M. Distefanoi* which have been illustrated by Gemmellaro. Prof. Gemmellaro, moreover, seems to have misunderstood my description of the surface of the shell in *M. elegans*. Otherwise he would certainly not call a shell smooth which in my description has been stated to be covered "with very numerous, irregularly clustered granulations and impressions, giving to the epidermis the appearance of shagreen."

The distinctive characters of *M. Distefanoi* have not, in my opinion, been sufficiently established to warrant the adoption of that species as proposed by Gemmellaro.

Prof. Frech (Die Dyas, Lethæa palæozoica, Bd. II, 3 Lfg., p. 509) doubtfully refers *Martinia acuminata*, Gemmellaro (l. c., p. 308, Tav. XXXII, figs. 29—32) to the synonyms of *M. elegans* and of *M. Distefanoi*. I feel, however, considerable uncertainty as to whether the present species should or should not be considered as specifically distinct from *M. acuminata*. Gemmellaro states that his types of *M. acuminata* are readily distinguished from examples of *M. Distefanoi* of equal size by their more compressed shape, their more acute apical angle, their deeper mesial sinus and by the considerably more obtuse angle in which the two valves unite.

*M. acuminata* seems indeed to be of a more slender shape than *M. elegans*. Such being the case, I have preferred to follow those authors, who, while admitting the very close relationship between both species, have still retained them as separate.

*Number of specimens examined.*—3.

### MARTINIA cf. SEMIPLANA, Waagen.

1883. *Martinia semiplana*, Waagen. Salt Range Fossils, Palæont. Indica, ser. XIII, vol. I, Productus Limestone Foss., p. 536, Pl. XLIII, fig. 4.

1897. *Martinia semiplana*, Diener. The permocarb. fauna of Chitichun No. I, Palæont. Indica, ser. XV, Himalayan Foss., vol. I, pt. 3, p. 52, Pl. VIII, fig 7.

For further synonyms the latter memoir should be consulted.

This small but characteristic species is represented in A. v. Krafft's collection by a single fairly complete specimen, exhibiting a very remarkable disproportion in the depth of the two valves. It is somewhat broader than my type-specimen from Chitichun No. I, with which it completely agrees in the rest of its characters.

### MARTINIA cf. NUCULA, Rothpletz.

1892. *Martinia nucula*, Rothpletz, Die Perm-Trias-und Juraformation auf Timor und Rotti, Palæontographica, 39 Bd., p. 80, Pl. IX, figs. 3—7.

1897. *Martinia nucula*, Diener. The permocarb. fauna of Chitichun No. I, Palæont. Indica, Ser. XV, Himalayan Foss., vol. I, pt. 3, p. 50, Pl. VIII, figs. 5—6.

1901. *Martinia nucula*, Enderle. Ueber eine anthracolithische Fauna von Balia Maaden in Kleinasien, Beiträge zur Geol. u. Palæont. Oesterreich-Ungarns, etc., XIII Bd., p. 85, Taf. VIII, fig. 1.

Two imperfect specimens of a large *Martinia* may be referred doubtfully to this species, which is characterized by the strongly inflated apical region and by the comparatively small, indistinctly defined area of its ventral valve.

The peculiar character of the area, which recalls *M. contracta*, Meek and Worthen, is very well exhibited in one of my two specimens. Exactly below the partly broken-off apex a large triangular fissure is exposed. Those portions of the shell which border the margins of the deltidial fissure pass so gradually into the lateral parts of the apical region, without any intervening ridges, that it is impossible to fix any definite borders to the area.

From the nearly allied *Martinia contracta* my specimens differ in the character of their frontal line, which, in the region of the sinus, ascends in a highly elevated, tongue-shaped curve.

In neither of my specimens are the apices of the two valves entirely preserved. From the shape of the portions still remaining, however, it is evident that they did not touch each other, as noticed by Rothpletz in his type-specimens from the permian rocks of Timor. I have not been able to observe this character in any of my specimens from Chitichun No. I, nor has it been noticed by Enderle in his specimen of *M. nucula* from the anthracolithic rocks of Balia Maaden in Asia Minor. I consequently do not consider this character of the types from Timor as a constant feature of specific value.

### RETICULARIA cf. LINEATA, Martin.

1897. *Reticularia cf. lineata*, Diener. The permocarbon. fauna of Chitichun No. I, Palæont. Indica, ser. XIII, Himalayan Foss., vol. I, pt. 3, p. 58, Pl. IX, figs. 5, 6, 8.

This species, which is the most common of the subgenus *Reticularia* in the permian fauna of Chitichun No. I, is also represented in A. v. Krafft's collection. The supposed identity of this species with *R. affinis*, Gemmellaro, will require further consideration. At present I can add nothing to what has been stated in the foregoing chapter of this memoir.

### RETICULARIA cf. PULCHERRIMA, Gemmellaro.

1899. *Reticularia pulcherrima*, Gemmellaro. La fauna dei calcari con Fusulina della valle del F. Sosio Fasc. IV, pt. I, p. 333, Pl. XXXIV, figs. 21—29.

A single incomplete ventral valve is provisionally referred to this species. I can add nothing to what has already been said with reference to the examples of *R. pulcherrima* from the permian limestone of Chitichun No. I, in the foregoing chapter of this memoir.

### RETICULARIA (SQUAMULARIA) cf. DIENERI, Gemmellaro (Pl. III, fig. 20).

1899. *Squamularia rotundata*, Gemmellaro. La fauna dei calcari con Fusulina della valle del F. Sosio, Fasc. IV, pt. 1, p. 326, Tav. XXXIII, figs. 38—45.
1899. *Squamularia Dieneri*, Gemmellaro. *Ibidem*, p. 327, Tav. XXXIV, figs. 1—4.
1900. *Spirifer* (*Reticularia*) *Dieneri*, Schellwien. Die Fauna der Trogkofelschichten in den Karnischen Alpen und den Karawanken, Abhandl. K. K. Geol. Reichs-Anst., Bd. XVI, p. 85, Taf. XII, figs. 9—17.

A new genus, *Squamularia*, has been introduced by Gemmellaro for those forms of *Reticularia* in which the ornamentation of the shell consists of concentric, undulating lines. Schellwien strongly objected to the generic inportance of this character. His objections are based on the studies of Davidson and Young, from which it is evident that the peculiar sculpture of *Squamularia* is restricted to the uppermost layer of the shell and does not differ essentially from the ornamentation of a typical *Reticularia*. Not having been able to examine Alpine or Sicilian specimens of *Squamularia*, I cannot speak as to its generic claims from personal observations. For the present, however, I prefer to follow in the path of Schellwien, in uniting *Reticularia* (*Squamularia*) *rotundata* with *R. Dieneri*.

*Reticularia Dieneri*, in the interpretation of Schellwien, is represented in A. v. Krafft's collection by a single, incomplete specimen. The apical and frontal regions have been partly broken off in both valves. The specimen is of strongly inflated, slightly elongate shape, resembling most nearly the example from Neumarktl, illustrated on Plate XII, fig. 12, of Schellwien's memoir, but of a little larger size. It is a cast with only a small portion of its shelly layer preserved. But this portion exhibits most clearly the ornamentation, which is considered by Gemmellaro as a character of generic importance. It consists of very distinctly marked, concentric striæ of growth, describing undulating, zig-zag lines.

My specimen is too incomplete to allow exact measurements to be given.

*Remarks.—Reticularia Dieneri* has been quoted from the permian Fusulina limestone of Sicily by Gemmellaro, and from the permocarboniferous rocks of the Eastern Alps by Schellwien.

### SPIRIGERA (ATHYRIS) ROYSSII, Léveillé.

1835. *Spirifer de Royssii*, Léveillé. Mém. Soc. géol. de France, II, p. 39, Pl. II, figs. 18—20.
1897. *Athyris Royssii*, Diener. The permocarbon. fauna of Chitichun No. I. Palæont. Indica, ser. XV, Himalayan Foss., vol. I, pt. 3, p. 59, Pl. X, figs. 1, 2, 3, 6.
For a complete list of synonyms I refer the reader to this memoir.

This species, which is the commonest leading fossil in the permian limestone of Chitichun No. I, is represented by a single specimen in A. v. Krafft's collection. My specimen agrees most closely with the somewhat inflated variety which has been illustrated on Plate X, fig. 3, of my memoir on the Chitichun fauna. It is of nearly circular, but slightly pentagonal outlines, nearly as long as broad, and provided with a very flat frontal wave.

The measurements of the specimen are as follows:—

| | | |
|---|---|---|
| Entire length of the shell | 28 | mm. |
| „ breadth „ „ „ | 30 | „ |
| Length of the dorsal valve | 26·5 | „ |
| Thickness of both valves | 17·5 | „ |
| Apical angle of the ventral valve | 105° | |
| Apical angle of the dorsal valve | 112° | |

I am still convinced of the correctness of my identification of the Himalayan shell with the carboniferous *Spirigera Royssii*. Quite a number of separate species have been fabricated by L. de Koninck from the varieties which were described as *Spirigera Royssii* by Davidson. But even if the species is retained in the exceedingly narrow circumscription of L. de Koninck, the majority of forms from the Chitichun fauna must be referred to it.

The type of *Spirigera Royssii* is represented in L. de Koninck's "Faune du calcaire carbonifère de la Belgique" (Annales du Musée d' hist. nat. de Bruxelles, vol. XIV, Pl. XIX, figs. 19—23, 28, 29). It is characterized by two equally vaulted, comparatively flat valves, which are united in a wavy frontal line, and by its somewhat transversely elongate shape. The differences between this type and some of my Himalayan shells are too small to justify a specific separation, notwithstanding L. de Koninck's statement that the true *Sp. Royssii* from the mountain limestone is distinct from all the shells collected from upper carboniferous and permian strata, which have been classed among its synonyms by the majority of palæontologists.

### SPIRIGERELLA DERBYI, Waagen, Pl. III, fig. 18.

1884. *Spirigerella Derbyi,* Waagen. Salt Range Fossils, Palæont. Indica, ser. XIII, vol. I, Productus Limestone Foss., p. 453, Pl. XXXV, figs. 4—7, 9—13; Pl. XXXVI, figs. 11—13; var. *acuteplicata*, p. 456, Pl. XXXV, figs. 10, 11; Pl. XXXVII, fig. 11.

1897. *Spirigerella Derbyi,* Diener. Himalayan Foss., Palæont. Indica, ser. XV, vol. I, pt. 4. The permian fossils of the Productus shales of Garhwál and Kumaon, p. 46, Pl. V, figs. 6, 8.

1897. *Spirigerella Derbyi,* Diener. *Ibidem*, vol. I, pt. 3. The permocarb. fauna of Chitichun No. I, p. 63 pl. XI, fig. 4.

There is a single specimen of this species in A. v. Krafft's collection. It agrees best with the examples from Kiunglung, which were collected in the permian Productus shales by C. L. Griesbach, and especially with representatives of the var. *acuteplicata*, Waag. Its sinus is produced towards the front into a tongue-shaped process, which causes the dorsal valve to ascend in a prominent though short and narrow fold. The beak of the ventral valve is firmly appressed to the apex of the opposite valve. This fact can be stated with full certainty notwithstanding slight injuries to the apical region.

The measurements of this specimen are as follows :—

| | |
|---|---|
| Entire length of the shell . . . . . . . | 15 mm. |
| ,, breadth of the shell . . . . . . . | 14·5 ,, |
| Length of the dorsal valve . . . . . . . | 13 ,, |
| Thickness of both valves . . . . . . . | 8·5 ,, |

*Number of specimens examined.*—1.

### ENTELETES TSCHERNYSCHEFFI, Diener.

1897. *Enteletes Tschernyscheffi*, Diener. The permocarbon. fauna of Chitichun No. I, Palæontologia Indica, ser. XV; Himalayan Fossils, vol. I, pt. 3, p. 67, Pl. V, figs. 7—10 (non fig. 11).

Specimens of this species, which is among the leading fossils of the permian fauna of Chitichun No. I, have also been obtained from the exotic block No. 9 in the neighbourhood of Sangcha Talla. As for their description I can add nothing to what has been stated in pp. 66—68 of the above memoir.

*Number of specimens examined.*—5.

### ENTELETES cf. ELEGANS, Gemmellaro, Pl. III, fig. 19.

1899. *Enteletes elegans*, Gemmellaro. La Fauna dei calcari con Fusulina della Valle del F. Sosio, Fasc. IV, Pl. I, p. 277, Tav. XXIX, figs. 6—10.

It is with some hesitation that I here introduce *Enteletes elegans* as a separate species, and in this respect I have followed Prof. Gemmellaro. He (l. c., p. 305) considers my *Enteletes Tschernyscheffi* to be very nearly allied to, but not identical with, his *E. elegans*. *E. Tschernyscheffi* is said to differ from the latter species by larger dimensions, by a more strongly developed mesial sinus and fold, by its longer ribs, which extend nearer to the apices in both valves, and by its less strongly inflated ventral valve. Prof. Frech (Die Dyas, Lethæa palæozoica, Bd. II, 3 Lfg., p. 509), on the contrary, believes *E. Tschernyscheffi* and *E. elegans* to be identical.

I must admit that I still find it very difficult to come to a decision on this point. There is among the specimens of *Enteletes* in A. v. Krafft's collection a solitary example, which is distinguished by its extremely inflated valves. The two valves are of nearly equal depth. This equivalve character of the shell seems to me the only one among the features of distinction enumerated by Gemmellaro on which a specific separation of *E. elegans* and *E. Tschernyscheffi* might perhaps be based. All the remaining characters, such as the development of the mesial sinus and fold, the length of plications, as well as the dimensions, are so variable in *E. Tschernyscheffi*, that no use can be made of them for a specific distinction from *E. elegans*. On the other hand, the present specimen is more strongly inflated than any of the Sicilian examples which have been illustrated by Gemmellaro. Thus it might be questioned whether it ought to be considered as a variety of *E. elegans* or to constitute a proper species. This point will require further consideration when more ample material has been obtained.

The measurements of this solitary specimen, which is with many misgivings provisionally referred to *E. elegans*, are as follows :—

| | |
|---|---|
| Entire length of the shell | 16 mm. |
| „ breadth of the shell | 16·5 „ |
| Length of the dorsal valve | 14 „ |
| „ „ „ hinge-line | 11 „ |
| Thickness of both valves | 19 „ |
| Height of the area of the smaller valve | 2·5 „ |

### UNCINULUS TIMORENSIS, Beyrich.

1865. *Rhynchonella timorensis*, Beyrick. Ueber eine Kohlenkalkfauna von Timor, Abhandlgn. Kgl. Akad. d. Wissensch., Berlin, 1864, p. 72, Taf. I, fig. 10.

1883. *Uncinulus Theobaldi*, Waagen. Salt Range Fossils, Palæontologia Indica, ser. XIII, vol. I. Productus Limestone Foss., p. 425, Pl. XXXIV, fig. 1.

1892. *Rhynchonella (Uncinulus) Timorensis*, Rothpletz. Die Perm.-Trias-und Juraform. auf Timor und Rotti, Palæontographica, 39 Bd., p. 87, Pl. X, fig. 6.

1897. *Uncinulus timorensis*, L. v. Lóczy. Die Wissenschaftlichen Ergebnisse der Reise des Grafen Bela Széchenyi in Ostasien, III. Bd., 4. Abth., p. 112, Taf. IV., fig. 10.

Several specimens of this species have been recorded from the exotic block No. 9, south-east of Tallah Kiogarh. I can add but little to what I have already said in my notes on the Chitichun fauna with reference to *Uncinulus timorensis* and its varieties, among which I do not class *U. jabiensis*, Waagen.

In one of my examples the ribs, although thinning out gradually, extend some way into the apical region, which is unfortunately partly broken off, thus recalling *U. velifer*, Gemmellaro, from the permian rocks of Sicily and Carniola. In all my specimens the median portion of the shells, corresponding to the mesial fold and sinus, is longer than the lateral parts. The number of ribs is extremely variable.

In one of my specimens only nine ribs are found within the median portion of the ventral valve, whereas in a second example the number of ribs in the same space amounts to eighteen.

*Number of specimens examined.*—4.

### UNCINULUS JABIENSIS, Waagen.

1883. *Uncinulus jabiensis*, Waagen. Salt Range Fossils, Palæont. Indica, ser. XIII, vol. I, Productus Limestone Foss., p. 427, Pl. XXXIV, fig. 2.

1900. *Uncinulus jabiensis*, G. v. Arthaber. Ueber das Palæozoicum in Hocharmenien und Persien, Beiträge zur Geol. u. Palæont. Oester.-Ungarns, etc., XII, p. 282, Taf. XXII, figs. 14, 15.

Among A. von Krafft's collections from the exotic block No. 9, south-east of Talla Kiogarh, a specimen of *Uncinulus* has been recorded, which agrees in all its essential characters with the specimen of *U. jabiensis* described and illustrated previously in my notes on Walker's collections from the permian limestone of Chitichun No. I.

It considerably exceeds the dimensions of the latter specimen, represented on Pl. II, fig. 5, of this memoir, but exhibits the same pentagonal outline and strongly compressed, inequivalve shape. The beak of the ventral valve has been slightly injured, otherwise this example is a fairly well preserved cast, with only very few traces left of its shelly substance. The numerous and delicate ribs are restricted to the vicinity of the margins.

The measurements of this specimen, which in its dimensions takes an intermediate position between Waagen's type-specimen from Jabi and the example from Chitichun No. I, discovered by Walker, are as follows :—

| | |
|---|---|
| Entire length of the shell | 14 mm. |
| „ breadth of the shell | 15 „ |
| Length of the dorsal valve | 12·5 „ |
| Thickness of both valves | 8 „ |

*Number of specimens examined.*—1.

### RHYNCHONELLA sp. ind. ex aff. RH. HOFMANNI, Krotow, Pl. III, fig. 12.

The description given by Krotow (Geologische Forschungen in den Gebieten von Tscherdyn und Ssolikamssk, Mém. Com. Géol. St. Pétersbourg, 1888, vol. VI, p. 422, Tab. I, figs. 31—33) of his *Rhynchonella Hofmanni* from the upper carboniferous limestone of Eastern Russia runs as follows :—

" A flat and very broad shell of triangular shape, with an apical angle of 105°. The valves are equally vaulted. The beak of the ventral valve is pointed and approximate to the apex of the opposite valve. The small deltidium is not distinctly visible. In the visceral part of the ventral valve a flat, median depression, rising in the middle of the valve, extends to the front, gradually increasing in width. To this depression a small mesial elevation in the dorsal valve corresponds. Five to six simple, radiating, acute ribs are counted within the mesial depression, three to four less prominent folds on each of the lateral parts. In advanced stages of growth the number of lateral ribs increases to six. In the vicinity of the beaks the lateral parts of both valves are smooth. To a length of 22 mm., a width of 30 mm. and a thickness of 11 mm. correspond."

In his memoir on the Brachiopoda of the upper carboniferous rocks of the Ural and Timan, Prof. Tschernyschew proposes to publish the illustrations of a smaller variety with a less obtuse apical angle and of nearly equal length and breadth.

It is to this—not yet described—small variety of ***Rhynchonella Hofmanni***, that a species of ***Rhynchonella*** from the exotic block No. 9, south-east of Talla Kiogarh, seems to be most nearly allied. The single but completely preserved specimen by which this species is represented, agrees with ***Rh. Hofmanni*** in the majority of its distinctive features, namely, in the triangular shape, in the presence of two flat valves of equal depth, which are provided with a very low, triangular median impression and corresponding elevation, and in the character of the radiating ornamentation. Six ribs are counted within the mesial depression and five on each side of the lateral parts of the ventral valve.

From ***Rh. Hofmanni*** my specimen chiefly differs by its acute apical angle, measuring 75° only, and by its ventral beak being a little more elevated above the apex of the dorsal valve, thus exhibiting a more distinctly developed deltidium. These differences are certainly sufficient to forbid an identification of the Himalayan specimen with ***Rh. Hofmanni***. On the other hand, I do not wish to burden nomenclature with a new specific name, which is based on a single though complete example only, being well aware of the fact that a satisfactory diagnosis of species of the genus *Rhynchonella* cannot be given without ample materials at hand for examination. "It is always very hazardous to establish species from the inspection of a single specimen, and specially among so variable a group of shells as that of the *Rhynchonellæ*."[1]

The measurements of the present specimen are as follows :—

| | |
|---|---|
| Entire length of the shell . . . . . . . | 12·5 mm. |
| „ breadth of the shell . . . . . . . | 11·5 „ |
| Length of the dorsal valve . . . . . . . | 11 „ |
| Thickness of both valves . . . . . . . | 5 „ |
| Apical angle of the ventral valve . . . . . | 75° |

***Remarks.***—I know of no other species of ***Rhynchonella*** to which the present one might advantageously be compared. In its triangular shape and in the flatness of its valves it somewhat recalls ***Rh. trilatera***, de Kon., but this remarkable carboniferous species is easily distinguished by the character of its beak, which, according to Davidson's description, is closely appressed to the apex of the dorsal valve, and by the presence of a median groove in the ventral valve.

---

[1] Davidson, A monograph of British carboniferous Brachiopoda, p. 103.

### CAMAROPHORIA PURDONI, Davidson.

1862. *Camarophoria Purdoni*, Davidson. Quart. Journ. Geol. Soc., London, vol. XVIII, p. 30, Pl. II, fig. 4.

For a complete list of synonyms I refer to my memoirs on the fauna of Chitichun No. I (Pt. 3 of this vol., p. 71) and on the Anthracolithic fossils of Kashmir and Spiti (Pt. 2, p. 79).

A number of specimens from the exotic block No. 9 in the vicinity of Sangcha Talla are referable to this species, which is one of the commonest fossils in the permian limestone crag of Chitichun No. I. Two specimens are fairly well preserved, and agree very closely with the typical form from Chitichun No. I and from the Salt Range Productus limestone. Large examples with more numerous ribs, which might be referred to the *var. gigantea*, Diener, have not been noticed among A. von Krafft's materials.

*Number of specimens examined.*—6.

### HEMIPTYCHINA cf. INFLATA, Waagen., Pl. III, fig. 24.

1882. *Hemiptychina inflata*, Waagen. Salt Range Fossils, Palæontologia Indica, ser. XIII, vol. I, Productus Limestone Fossils, p. 372, Pl. XXVII, figs. 7—9.

1897. *Hemiptychina inflata*, Diener. The permocarbon. fauna of Chitichun No. I, Himalayan Fossils, ser. XV, vol. I, Pt. 3, p. 77, Pl. XII, fig. 3.

No complete specimen of this species has come to my knowledge, but three fragmentary examples have been discovered among the fossil materials collected by A. v. Krafft. I should have united them with *Hemiptychina inflata* without the slightest hesitation, had not their unsatisfactory state of preservation prevented me from doing so. The most completely preserved specimen—that which has been figured—agrees very closely with my type-specimen from Chitichun No. I, especially so in the remarkable geniculation of the ventral valve. In a second example the frontal region, which has been entirely preserved, exhibits ten folds which do not, however, extend beyond the geniculation in the visceral portion of the valve.

I must admit that the specific claims of *H. flinata* are very uncertain. The numerous series of intermediate shapes by which *H. inflata*, *H. sparsiplicata*, Waagen, and *H. himalayensis*, Dav., are linked together, necessarily lead to the conclusion that they are all merely variations of a single species, for which the name *H. himalayensis* ought to be retained.

*Number of specimens examined.*—3.

### NOTOTHYRIS TRIPLICATA, Diener.

1897. *Notothyris triplicata*, Diener. The permocarbon. fauna of Chitichun No. I, Palæont. Indica, ser. XV, Himalayan Fossils, vol. I, Pt. 3, p. 78, Pl. XIII, figs. 1, 2.

One single but entirely preserved example of this species, which is very numerously represented in the Chitichun fauna, has been discovered among A. von

Krafft's materials from the exotic block No. 9, south-east of Talla Kiogarh. It exactly agrees in shape and ornamentation with my type-specimens from Chitichun No. I.

### NOTOTHYRIS MEDITERRANEA, Gemmellaro, Pl. III, fig. 14.

1899. *Rostranteris mediterraneum*, Gemmellaro. La fauna dei calcari con Fusulina della Valle del F. Sosio. Fasc. IV, pte. I, p. 244, Tav. XXV, fig. 1—6 ; Tav. XXVI, fig. 59.

In the first chapter of this memoir the discovery of this Sicilian species among the Chitichun fossils collected by Walker in 1899 has been recorded. In A. v. Krafft's collection this species is also represented by a single but perfectly preserved specimen. It is medium-sized, more strongly inflated than the Chitichun examples, but otherwise agreeing with the latter in its elongate, posteriorly compressed shape, and especially in its sculpture.

The triplicate frontal wave is very distinctly developed. A very short and low lateral fold accompanies the two prominent frontal folds of the ventral valve on each side. On the dorsal valve no lateral folds are noticed beyond the three prominent but short frontal folds.

The measurements of this specimen are as follows :—

| | | |
|---|---|---|
| Entire length of the shell . . . . . . | 11 | mm. |
| „ breadth „ „ „ . . . . . . | 8 | „ |
| Length of the dorsal valve . . . . . . | 8·5 | „ |
| Thickness of both valves . . . . . . | 7·5 | „ |

*Number of specimens examined.*—1.

### NOTOTHYRIS MINUTA, Waagen, Pl. III, fig. 13.

1882. *Notothyris minuta*, Waagen. Salt Range Fossils, Palæontologia Indica, ser. XIII, vol. I, Productus Limestone Fossils, p. 336, Pl. XXVIII, figs. 7, 8.

This species has been described by Waagen as a representative of the group of *Nototbyris subvesicularis*, Dav., or *N. Warthi*, Waagen, from which it is easily distinguished by its small size and by the character of its ornamentation. The materials of this species in A. v. Krafft's collections are rather scanty, but the specimens are so satisfactorily preserved, that I think the determination can be made with sufficient accuracy.

My specimens are of small size, barely exceeding 10 mm. in length, and of a broadly lenticular shape. The ventral valve is considerably more strongly vaulted than the opposite one. In one of my examples it is regularly arched, in the second it exhibits a sort of indistinct geniculation, corresponding to the middle of the visceral portion. The short beak is pierced by a moderately large foramen and bordered by a false area, which is not distinctly limited off from the remainder of the shell. The sculpture of the ventral valve consists of eight prominent and acute folds, two of them on the frontal and three on each of the lateral parts. They originate in the vicinity of the apical region, covering a little more than two-thirds of the entire length of the shell. To the two frontal folds, which are the most prominent, three frontal folds correspond in the dorsal valve. Thus a distinctly triplicate wave is formed in the front-margin. Waagen especially remarks that the median part of the frontal region is distinctly depressed, and the median fold of the dorsal valve on a lower level than the two external ones. This peculiarity, in the illustration of which he has not succeeded according to his own statement, is very clearly exhibited in both of my specimens.

The measurements of the two specimens are as follows :—

| | I. | II. |
|---|---|---|
| Entire length of the shell . . . | 11 mm. | 10 mm. |
| „ breadth „ „ „ . . . . . . | 10 „ | 9 „ |
| Length of the dorsal valve . . . . . | 9 „ | 8·5 „ |
| Thickness of both valves . . . . . . | 9 „ | 8 „ |

*Number of specimens examined.*—2.

*Remarks.*—*Notothyris minuta* has been quoted by Waagen from the middle division of the Productus limestone of the Salt Range.

## NOTOTHYRIS OVALIS, Gemmellaro, Pl. III, fig. 16.

1899. *Rostranteris ovale*, Gemmellaro. La fauna dei calcari con Fusulina della valle del F. Sosio, Fasc. IV, pte. I, p. 248, Tav. XXV, figs. 26—41.

1900. *Notothyris ovalis*, Schellwien. Die Fauna der Trogkofelschichten in den Karnischen Alpen und den Karawanken, Abhandl. K. K. Geol. Reichs-Anst., XVI. Bd., p. 103, Taf. XV, figs. 9—12.

A single but very well preserved example exhibits the characteristic shape and sculpture of this species of *Notothyris*. It is especially Gemmellaro's type-specimen illustrated in fig. 49 with which it agrees even in its minor details, only excepting its smaller dimensions.

My specimen is of an elongate outline with a truncated frontal margin. The two valves are of unequal depth, the ventral being the more strongly inflated. It is regularly arched longitudinally but very steeply inclined transversely along the lateral parts.

The ventral valve is provided with four folds. The two central are large, prominent, but not acute at their tops, and separated by a deep valley extending from the front into the apical region. The two lateral folds are very short and low. In the dorsal valve three folds are noticed, the median being shorter than the two lateral ones, which, however, do not extend so far into the apical region as in the opposite valve. The bordering valleys unite in front of the shorter median fold.

Of the internal characters of the specimen nothing is known to me.

The measurements of this specimen are as follows :—

| | |
|---|---|
| Entire length of the shell . . . . . . . | 7 mm |
| „ breadth „ „ „ . . . . . . . | 4·5 „ |
| Length of the dorsal valve . . . . . . . | 6 „ |
| Thickness of both valves . . . . . . . | 4·5 „ |

*Number of specimens examined.*—1.

*Remarks.*—*Notothyris ovalis* has been quoted from the permian Fusulina limestone of Sicily by Gemmellaro, and from the permocarboniferous strata of Neumarktl in Carniola by Schellwien. Schellwien hints that the species ought possibly to be united with *Dielasma Toulai*, Schellwien, (Palæontographica, 39 Bd., p. 55, Taf. VIII., fig. 19) from the upper carboniferous Fusulina limestone of Carinthia. It seems, however, to differ from *N. ovalis* by its more broadly lenticular shape and by its deeply incised frontal margin. From *N. nucleolus*, Kutorga, from the upper carboniferous Schwagerina limestone of the Ural Mountains our species is distinguished by its elongate outlines.

### NOTOTHYRIS cf. WALKERI, Diener, Pl. III, fig. 15.

In my introduction of this new species in the first chapter of the present memoir it was proposed to complete its diagnosis by the description of an example from the exotic block No. 9, south-east of Talla Kiogarh, which may possibly belong to the group of *Notothyris Walkeri*, if this species is taken in wider circumscription.

My example is referred to provisionally as *N.* cf. *Walkeri*, although it does not agree entirely with the type-specimen from Chitichun No. I. But in my opinion the differences do not exceed the limits of individual variability, which must be admitted in shells of such variable shape as the representatives of the genus *Notothyris*. These differences consist in the stronger development of the two lateral ridges, which run parallel to the median crest. Thus the helmet-shaped character of the transverse section is restricted to the apical region, whereas in the highly arched profile of the visceral portion, the top of the helmet consists of three closely arranged crests of equal height. In this feature our specimen recalls *N. triplicata*.

In the frontal line of the specimen from Chitichun No. I only very small marginal indentations are noticed. In the present specimen these indentations are much more distinctly developed. In their arrangement they exhibit the tendency peculiar to the genus *Notothyris* to bend the frontal line in the direction of the ventral valve. The indentations corresponding to the three crests of the frontal part are not situated on the same level with those of the lateral parts. The internal characters of the species being unknown, it is on account of this configuration of the frontal line that it may be safely attributed to the genus *Notothyris*,—not to *Hemiptychina*.

The measurements of the present species are as follows:—

| | |
|---|---|
| Entire length of the shell . . . . . . . | 11 mm. |
| ,, breadth ,, ,, ,, . . . . . . . | 7 ,, |
| Length of the dorsal valve . . . . . . . | 8·5 ,, |
| Thickness of both valves . . . . . . . | 9 ,, |

*Number of specimens examined.*—1.

*Remarks.*—From the characters by which this specimen differs from my type of *Notothyris Walkeri* from Chitichun No. I, it is evident that the species is rather nearly related to *N. triplicata*, notwithstanding its peculiar shape, by which it is easily distinguished from all the remaining congeneric forms.

## ECHINODERMATA.

### POTERIOCRINUS (?), sp. ind., Pl. III, fig. 25.

It is entirely provisionally that I attribute some fragments of stems in A. von Krafft's collections to the genus *Poteriocrinus*. I must explicitly remark that there is nothing from which I could deduce the presence of this genus in the fauna of the exotic block No. 9, in the neighbourhood of Sangcha Talla, with any greater certainty than in the Chitichun limestone.

The fragments which I consider as belonging to *Poteriocrinus* are of large size and of circular outlines. They consist of single joints only, which are rather low, their height measuring only a little more than one-fourth of their diameter.

The central canal is of cylindrical shape with a circular outline. At a short distance from this central canal very numerous radiating cirrhi originate, which increase in number by bifurcation.

The measurements of the figured joint are as follows:—

| | |
|---|---|
| Diameter of the joint . . . . . . . | 25 mm. |
| Height „ „ „ . . . . . . . | 7 „ |
| Diameter of the central canal . . . . . . | 4 „ |

Among the types of *Entrochi* which have been established by Rothpletz (Palæontographica, 39 Bd., p. 72) the present joint belongs to the section of *Entrochi regulares* and is most nearly allied to the type *a*, which is represented by the specimen from Batu-duduk (Island of Timor) illustrated on Pl. XIII, fig. 38*a*, of the above-quoted memoir. From this joint my Himalayan example differs by its still greater height and by the slightly larger diameter of its central canal, also by the presence of a smooth zone bordering the latter.

Among the joints illustrated by Waagen the specimen figured on Pl. XCVI, fig. 16, might be compared with this specimen but is distinguished by the smaller size and height of its single joints.

## FAUNISTIC AND STRATIGRAPHICAL RESULTS.

The fauna of the exotic block No. 9 in the neighbourhood of Sangcha Talla is composed of the following species:—

### LAMELLIBRANCHIATA.

1. *Aviculopecten* cf. *hiemalis*, Salter.
2. *Leiopteria*, sp. ind.
3. *Lima* sp. ind. aff. *retifera*, Shum.

### GASTEROPODA.

4. *Naticopsis khurensis*, Waagen.
5. *Bellerophon* sp. ind. aff. *polito*, Waagen.
6. *Pleurotomaria* (*Mourlonia*) *hunica*, nov. sp.

### BRACHIOPODA.

7. *Productus Abichi*, Waagen.
8. „ *chitichunensis*, Diener.
9. „ *gratiosus*, Waagen.
10. „ cf. *mongolicus*, Diener.
11. „ cf. *undatus*, Defr.
12. „ *plano-hæmisphærium*, Netsch.
13. *Marginifera typica*, Waagen.
14. „ *helica*, Abich.
15. *Scacchinella* sp. ind.
16. *Lyttonia* cf. *nobilis*, Waagen.
17. *Orthothetes Kraffti*, nov. sp.
18. *Spiriferina* cf. *octoplicata* var. *fastigata*, Schellwien.
19. *Spirifer Wynnei*, Waagen.
20. „ *tibetanus*, Diener.
21. „ *fasciger*, Keyserl.
22. „ sp. ind. ex aff. *Marcoui*, Waagen.
23. *Martinia acutomarginalis*, Diener.
24. „ *elegans*, Diener.
25. „ cf. *semiplana*, Waagen.
26. „ cf. *nucula*, Rothpletz.
27. *Reticularia* cf. *lineata*, Martin.
28. „ cf. *pulcherrima*, Gemmell.
29. „ (*Squamularia*) cf. *Dieneri*, Gemmell.
30. *Spirigera* (*Athyris*) *Royssii*, Léveilé.
31. *Spirigerella Derbyi*, Waagen.
32. *Enteletes Tschernyscheffi*, Diener.
33. „ cf. *elegans*, Gemmell.
34. *Uncinulus timorensis*, Beyr.
35. „ *jabiensis*, Waagen.
36. *Rhynchonella* sp. ind. ex aff. *Hofmanni*, Krotow
37. *Camarophoria Purdoni*, Dav.
38. *Hemiptychina* cf. *inflata*, Waagen.
39. *Notothyris triplicata*, Diener.
40. „ *mediterranea*, Gemmell.
41. „ *minuta*, Waagen.
42. „ *ovalis*, Gemmell.
43. „ cf. *Walkeri*, Diener.

### ECHINODERMATA.

44. *Poteriocrinus* sp. ind. (?).

Altogether 44 species, among which the Brachiopoda, numbering 37 species, by far predominate both in species and individuals, and comprise a little less than five-sixths of the entire fauna. Leaving out of discussion those forms which do not admit of specific determination, there remain 37 species. Only two among them are new and have not been hitherto described. These species are :—

*Pleurotomaria hunica.*
*Orthothetes Kraffti.*

Of the remaining 35 species not less than 26—almost three-fourths—are identical with permian species from the Chitichun limestone. This fact points very strongly in favour of a homotaxis of the fauna of the exotic block No. 9, south-east of Talla Kiogarh, with the fauna of Chitichun No. I, or with that of the topmost beds of the middle Productus limestone of the Salt Range.

The remaining fossils, which are identical with such as have been found in other regions, fully corroborate this conclusion. Such fossils are—

1. *Aviculopecten* cf. *hiemalis*, Salt.
2. *Naticopsis khurensis*, Waag.
3. *Productus* cf. *undatus*, Defr.
4. „ *plano-hæmisphærium*, Netsch.
5. *Marginifera helica*, Abich.
6. *Reticularia* cf. *Dieneri*, Gemm.
7. *Enteletes* cf. *elegans*, Gemm.
8. *Notothyris minuta*, Waag.
9. „ *ovalis*, Gemm.

Among these nine species three are probably identical with permian forms from the Sosio limestone of Sicily, two with forms from the middle Productus limestone of the Salt Range. *Aviculopecten hiemalis* is a leading fossil of the permian Productus shales of Painkhanda. *Productus plano-hæmisphærium* is quoted from the permian strata of Central Russia, *Marginifera helica* from the permian Otoceras beds of Djulfa in Armenia. With these eight species, which, together with the elements of the Chitichun fauna, impart to the present fauna a decidedly permian aspect, only a single carboniferous type, *Productus* cf. *undatus*, is associated.

Thus the homotaxis of the fauna of the exotic block No. 9, in the neighbourhood of Sangcha Talla, with the faunæ of Chitichun No. I in the Himalayas, and of the upper limit of the middle Productus limestone in the Salt Range, appears to be established with as great certainty as could be desired. From the result of the present examination the correctness of the correlation given in A. v. Krafft's preliminary report is evident, although much less material was then available.

## III.—FOSSILS FROM THE PRODUCTUS SHALES OF THE LISSAR VALLEY (JOHÁR).

In the upper valleys of the Lissar ganga and Dharma ganga in Johár the permian Productus shales have been most carefully studied by C. L. Griesbach (Geology of the Central Himalayas, Memoirs, Geological Survey of India, vol. XXIII, 1891, pp. 172—178). The fossils collected by him were described by me in the fourth part of the present volume. The fauna was found to be very rich in individuals, but rather poor in species. The following species of Brachiopoda have been recorded :—

*Chonetes lissarensis*, Diener.
*Productus* sp. ind.
*Spirifer Ravana*, Diener.
" *fasciger*, Keyserl. (=*musakheylensis*, Dav.)
" *joharensis*, Diener.
*Spirigera Gerardi*, Diener.

In 1899 Mr. T. D. LaTouche was deputed to the upper Lissar valley and a large collection of fossils was made in the Productus shales from several localities chiefly from the slopes on the left bank of the valley, two miles south of the snowy peak Dharma No. XI, from the ridge between Lissar and Dharma valleys, opposite Kharsa glacier, and from the right side of the Bambadhura north glacier.

The fossils are, as a rule, badly preserved, and very difficult to extract from the exceedingly tough matrix. Brachiopoda by far predominate, both in number of species and individuals. Nevertheless the palæontological examination of the fossils has yielded some interesting results, especially with regard to an exact stratigraphical correlation with certain beds of the Kuling series of Spiti.

### GASTEROPODA.

#### PLEUROTOMARIA cf. PUNJABICA, Waagen, Pl. V, figs. 1, 2, 3.

1880. *Pleurotomaria punjabica*. Waagen. Salt Range Fossils, Palæontologia Indica, ser. XIII, vol. I, Productus Limestone Foss., p. 115, Pl. XI, figs. 3, 4.

Three incomplete casts of a *Pleurotomaria* belonging to Sandberger's section of *multicarinatæ* are probably identical with Waagen's species from the Productus limestone of the Salt Range. My specimens are not sufficiently complete to allow a direct identification, but agree most closely with ***Pleurotomaria punjabica*** in all characters that can be recognised.

All my specimens are of somewhat larger size than Waagen's types, but otherwise of the same shape and sculpture. The depressed spire consists of only a small number of whorls, but their exact number cannot be ascertained, the apex having been broken off in all my specimens. The body-whorl is very much larger than the preceding ones, but neither its aperture nor its base have been entirely preserved. The presence of a moderately deep umbilicus can, however, be noticed. The profile of the body-whorl is not evenly rounded. It exhibits a regular curve from the base to the middle of its height. Then follows a flattened zone between the median line of the profile and the slit-band, which is narrow, angular and bordered on each side by a sharp, slightly elevated ridge. From the slit-band to the suture of the anterior whorl in the spire the body-whorl describes a very flatly arched curve.

In one of my specimens the shell has been partly preserved, and we thus get an idea of its ornamentation, which in casts consists of very indistinct spiral striæ. The fragments of the shell, however, are covered with numerous angular spiral ridges, which are intersected by a very large number of delicate, transverse striæ of growth.

The measurements of the smallest of the three figured specimens are as follows:—

| | |
|---|---|
| Total length of the shell . . . . . . . . | ca. 16 mm. |
| Greatest breadth of the shell . . . . . . . . | 17 „ |
| Height of the last volution . . . . . . . . | 9 „ |
| Breadth of the body-whorl near the aperture . . . . | 9 „ |

*Locality: Number of specimens examined.*—Slopes on left bank of Lissar valley, two miles south of Dharma XI: 3.

*Remarks.*—In view of the poor state of preservation of my specimens I dare not enter into a discussion of the affinities of the present species to other congeneric forms. It may, however, be stated that this species must be considered as belonging to *Pleurotomaria sensu stricto*, even if the latter species is accepted in the narrow circumscription of L. de Koninck.

### NATICOPSIS sp. ind., Pl. IV, fig. 1.

The fragmentary state of the only representative of this genus renders it absolutely unfit for a specific determination. The spire is well preserved, but base and aperture of the body-whorl have been entirely broken off. In dimensions, shape and character of ornamentation it is not unlike *Naticopsis minuta*, Gemmellaro (La Fauna dei calcari con Fusulina della Valle del f. Sosio, Fasc. II, Palermo 1889, p. 136, Tav. XV, figs. 5, 6), or *N. cadorica*, Stache (Beiträge zur Kenntniss der Fauna der Bellerophonkalke Suedtirols, Jahrb. K. K. Geol. Reichs-Anst., XXVII. Bd., 1877, p. 317, Taf. V, figs. 6, 8). Its surface is covered with very numerous and delicate striæ of growth.

*Locality: Number of specimens examined.*—Near crest of ridge between Lissar and Dharma valleys, opposite Kharsa glacier: 1.

### BELLEROPHON sp. ind., Pl. IV, fig. 2.

This species is represented by an imperfect cast, with the larger portion of the body-whorl broken off. It is symmetrical, with regularly rounded inner whorls, but with an obtusely angular peripheral part in the body-whorl. The umbilicus seems to be rather wide, but from this character in the cast no conclusion can be drawn as to the shape of the umbilicus in the shell.

The specimen is too fragmentary to determine its relationship to other congeneric forms.

*Locality: Number of specimens examined.*—Slopes on left bank of Lissar valley, 2 miles south of Dharma XI: 1.

## BRACHIOPODA.

### CHONETES sp. ind. cf. URALICA, Mœller, Pl. V, fig. 4.

Compare—

1862. *Chonetes uralica*, Mœller. The mountain limestone-formation of the Ural Range (in Russian), Gorny Journal IV, p. 177, Pl. IX, fig. 1.

1890. *Chonetes uralica*, Nikitin. Depôts carbonifères et puits artésiens dans la région de Moscou, Mém. Com. Géol. St. Petersbourg, vol. V, No. 5, p. 61, Pl. II, figs. 5—9.

In La Touche's collection this species is represented by two ventral valves, with their shelly layer preserved, but partly injured by weathering. They are very similar to *Chonetes Vishnu*, Salter, one of the leading fossils of the Productus shales of Painkhánda.

In my memoir on the fauna of the Productus shales of Kumaon and Garhwál (Pt. 4 of the present volume, p. 14) I have alluded to the very close relationship of *Ch. Vishnu* to the European *Ch. uralica*. Their distinctive characters are obscured by the fact that in *Ch. Vishnu* only fragmentary portions of the shell were available to me for observation, nearly all the examples from Kiunglung being internal casts. Nevertheless, I think the present species might be distinguished from *Ch. Vishnu* by differences in the shape of the mesial sinus, which is not deeply incised, but of triangular outlines, widening considerably toward the front. This character has not been well shown by the draughtsman in the illustration.

A second distinctive feature consists in the more regularly convex shape of the present specimens, both in longitudinal and transverse directions. In *Ch. Vishnu* the ventral valve is strongly flattened in the vicinity of the lateral and frontal margins, and there is a distinctly defined demarcation between the more strongly curved visceral region and the flattened marginal portions of the shell. In the present specimens the valve is more regularly and equally curved and not bordered by a flattened zone along the front and lateral margins.

In one of my specimens obliquely directed tubes are indistinctly visible on the cardinal edges.

The sculpture consists of very numerous and delicate radiating striæ, which increase in number towards the front both by bifurcation and intercalation. The illustration is, unfortunately, not apt to convey a clear idea of this ornamentation.

My specimens agree very nearly with *Ch. uralica* among the European, and with *Ch. Flemingi*, Norwood and Pratten (Notice of the genus *Chonetes*, as found in the Western States and Territories, Journ. Acad. of Nat. Sciences of Philadelphia, III, 1855, p. 26, Pl. II, fig. 5), among the American representatives of the genus *Chonetes*; Nikitin states that both species differ only in the internal characters of their valves. I prefer to class my Himalayan specimens with *Ch. uralica*, since the correctness of the figures in Norwood's and Pratten's memoir is somewhat doubtful.

The measurements of the figured specimen are as follows:—

| | |
|---|---|
| Entire length of the shell . . . . . . | 9 mm. |
| „ breadth „ „ „ . . . . . | 13 „ |
| Thickness of the ventral valve . . . . . | 3·5 „ |

*Locality: Number of specimens examined.*—Near crest of ridge between Lissar and Dharma valleys, opposite Kharsa glacier: 2.

*Remarks.*—In my memoir on the fauna of the permian Productus shales of Kumaon and Garhwál *Ch. Verneuiliana*, Norwood and Pratten, had been quoted among the nearest allies of *Ch. Vishnu* and *Ch. uralica*. This species had, however, not been sufficiently illustrated, either by Norwood and Pratten (l. c., Pl. II, fig. 6) or by Meek (Palæontology of Eastern Nebraska in Meek and Hayden, Final Report of the U. S. Geol. Survey of Nebraska, 1872, Pl. I, fig. 10). The illustrations of Hall and Clarke (Palæontology of New York, vol. VIII, pt. I, 1892, Pl. XVI, figs. 20, 21) clearly show that it belongs to a group of forms which differ considerably from my Himalayan species. The widely extended wings and the deeply incised angular sinus make a distinction fairly easy.

### PRODUCTUS cf. GANGETICUS, Diener.

1897. *Productus gangeticus*, Diener. The permian fossils of the Productus shales of Kumaon and Garhwál, Palæontologia Indica, ser. XV, Himalayan Fossils, vol. I, pt. 4, p. 23, Pl. I, fig. 1; Pl. II, fig. 3.

The cast of a very large dorsal valve is provisionally referred to this species, which had hitherto not been found outside the Productus shales of Kiunglung near the Niti Pass. My specimen is very similar to the casts which have been illustrated in Pl. II, fig. 3, of my above-quoted memoir, but exceeds them considerably in its dimensions.

The apical region is but very incompletely preserved. In its general shape this valve differs from my type-specimens by being flatly concave, as in *P. Abichi*, Waag. It is, however, provided with a broad and flat median fold only, no lateral folds being developed, as in *P. Abichi*. The frontal and lateral margins of the cast are separated from the trail by a very sharp geniculation.

The sculpture of the cast consists of numerous coarse, club-shaped tubercles, which correspond to deep, elongated grooves in the shell of the valve.

Of the internal arrangement, which is the most distinctive feature of *P. gangeticus*, the two diverging ridges, which form a continuation of the bipartite cardinal process, and the sharp median septum are partly exposed. The latter extends far into the visceral portion of the valve.

The length of this valve without the apex is about 60 mm., and corresponds to a width of 85 mm., being thus more than twice as great as the measurements of my type-specimen from Kiunglung.

*Locality: Number of specimens examined.*—Slopes on left bank of Lissar valley, 2 miles south of Dharma XI: 1.

### PRODUCTUS sp. ind. (cf. PURDONI, Dav. ?).

An incomplete fragment of the internal cast of a ventral valve recalls *Productus Purdoni*, Davidson (Quart. Journal Geol. Soc., vol. XVIII, 1862, Pl. 31, l. II, fig. 5), but is too badly preserved to admit of specific determination. It is mentioned here on account of its very large size. So far as we may judge from the fragment, the complete specimen can barely have measured less than 90 mm. in length and 70 mm. in breadth. It was certainly considerably larger than the largest specimen of *P. Purdoni* illustrated by Waagen from the Productus limestone of Chidru.

*Locality: Number of specimens examined.*—Slopes on left bank of the Lissar valley, 2 miles south of Dharma XI: 1.

### MARGINIFERA HIMALAYENSIS, Diener, Pl. V, figs. 5, 6.

1899. *Marginifera himalayensis*, Diener. Anthracolithic Fossils of Kashmir and Spiti, Palæontologia Indica, ser. XIV, Himalayan Fossils, vol. I, pt. 2, p. 39, Pl. II, figs. 1—7; Pl. VI, figs. 1, 2.

For a complete list of synonyms the reader is referred to the above memoir.

This species, which is the commonest leading fossil in the Kuling shales of Spiti, forms entire layers of shells, together with *Spirifer Rajah*, Salter, in the Productus shales of the Lissar valley. The specimens are embedded in rocks of exactly the same lithological character as in Spiti—dark, crumbling shales, rich in mica and with limestone partings. Their state of preservation is, as a rule, as indifferent as in the Kuling shales of Spiti. Fairly complete examples are exceedingly rare.

In my description of this species both its variability and its close relationship to *Marginifera typica*, Waag., have been stated. To the types figured on Pl. II and Pl. VI of the second part of this volume, which are all represented in La Touche's collection, a new and remarkable one must be added.

In the above memoir I have alluded to the presence of a small number of examples from the Kuling shales of Muth, which were distinguished from the rest by a slightly more pronounced ornamentation of their ventral valves. Among the materials from the Productus shales of the Lissar valley a few specimens may be picked out in which this form of sculpture is still more strongly developed. These specimens are covered with sharp radial ribs occasionally bifurcating and converging towards the deep, but comparatively narrow, mesial sinus. In their shape and sculpture they strongly recall *Productus gratiosus*, Waagen. I should indeed be at a loss how to distinguish them had I to deal with only ventral valves in which the wings had been broken off. The character of the wings, however, is a good means of distinction; they are very small, though distinctly defined, in *P. gratiosus*, whereas they are large, prominent and somewhat triangular in *Marginifera himalayensis*. There is no difficulty in distinguishing a complete specimen of *M. himalayensis* from *P. gra-*

*tiosus*, the dorsal valve of the former species being characterised by its strongly developed reticulation, which imparts to the casts of this valve an external similarity with small forms of *P. semireticulatus*.

No intermediate types between this species and *Marginifera typica*, Waagen, have been noticed among the rich materials collected by Mr. La Touche.

The characteristic feature of sub-generic importance in *Marginifera*, namely, the prominent, shelly ridge within the wings of the ventral valve and the internal ridges corresponding to the margin of the dorsal valve, are but rarely accessible to observation. I have never seen them so distinctly developed as in some of my type-specimens from the Kuling shales of Spiti and from the corresponding beds in Kashmir.

*Locality: Number of specimens examined.*—Slopes on left bank of Lissar valley, 2 miles south of Dharma XI, 26; right side of Bambadhura north glacier, near crossing, Lissar valley, 20; near crest of ridge between Dharma and Lissar valleys opposite Kharsa glacier, 36.

### SPIRIFER RAJAH, Salter, Pl. IV, Figs. 3, 4, 5.

1865. *Spirifer rajah*, Salter. Palæontology of Niti in the Northern Himalayas, pp. 59, 111.
1899. *Spirifer rajah*, Diener. Anthracolithic Fossils of Kashmir and Spiti, Palæontologia Indica, ser. XV, Himalayan Fossils, vol. I, pt. 2, p. 68, Pl. IV, figs. 1—7, Pl. V, fig. 1.

For a complete list of synonyms the latter memoir should be consulted.

This beautiful species is very largely represented in La Touche's Himalayan collection. It has, as a rule, been found associated with *Marginifera himalayensis*.

The variability of the species is very considerable. There are both broad and narrow, thick and flat, forms present among my materials. The shape of the sinus varies to a great extent. In general it is broadly rounded at its base, but in one of my specimens (fig. 5) its lateral parts unite in a sharp edge. In one of the largest individuals, which otherwise agrees perfectly with typical examples of *Spirifer rajah* (fig. 3), barely any trace of a median rib can be observed in the bottom of the sinus. But this exceptional appearance cannot be taken as the normal condition of the species, and must be regarded merely as a malformation. In a second example (fig. 4) the median rib, which, in the remaining form, is thread-like and delicate, considerably increases in height and breadth towards the front, thus assuming the shape of a rather prominent element of sculpture.

All my specimens are ventral valves.

*Locality: Number of specimens examined.*—Slopes on left bank of Lissar valley, 2 miles south of Dharma XI, 15; ridge between Lissar and Dharma valleys opposite Kharsa glacier, 10; right side of Bambadhura north glacier, near crossing, Lissar valley, 4.

*Remarks.*—Prof. Frech (Neues Jahrb. f. Mineral., 1902, I, p. 263) declares *Spirifer rajah* to be barely distinguishable as a variety from *Sp. Keilhavii*, v. Buch. Notwithstanding Prof. Frech's statement to the contrary, I can see no reason why they should not be considered as different species, as they can be distinguished by the shape of their mesial fold in the dorsal valve. This fold is divided in the middle by a broad and shallow longitudinal depression or groove in *Spirifer Keilhavii*, but becomes a sharply rounded crest in *Sp. rajah*. It is of course only a matter of taste, whether or not such differences are to be regarded as valid grounds for a specific or varietal separation, but, in my opinion, an author who is ready to accept *Spirifer Ravana* as a proper species, as has been done by Prof. Frech, is not justified in refuting a specific separation of *Sp. rajah* from *Sp. Keilhavii*.

### SPIRIFER cf. RAVANA, Diener.

1897. *Spirifer Ravana*, Diener. Permian Fossils of the Productus shales of Kumaon and Garhwál, Palæontologia Indica, ser. XV, Himalayan Fossils, vol. I., pt. 4, p. 34, Pl. III, figs. 1, 2.

1898. *Spirifer Ravana*, Frech. Ueber marine Dyas—Brachiopoden aus Australien. Zeitschr. Deutsche Geo. Ges., 1898, p. 180, Taf. IV, figs. 7, 8.

An incomplete ventral valve is provisionally referred to this species, which is most nearly allied to *Spirifer Marcoui*, Waag. In its dimensions it is considerably inferior to my type-specimens from the Lissar Valley and from Kiunglung E. G.; the sinus is limited on both sides by obtuse ridges, but is too poorly preserved to allow the character of its bottom to be clearly noticed. Indistinct, shallow folds are developed on each side of the deeply impressed mesial sinus.

*Locality: Number of specimens examined.*—Slopes on left bank of Lissar valley, two miles south of Dharma XI: 1.

### SPIRIFER FASCIGER, Keyserling,

### (= SPIRIFER MUSAKHEYLENSIS, Davidson).

This species is represented by a small number of typical examples in La Touche's collection. The largest specimen somewhat exceeds in size my type from the Productus shales of Kiunglung E. G. (Pt. 4 of the present volume, Pl. V, fig. 1), but differs from it in the more strongly developed convexity of its folds, corresponding to the fasciculi of ribs. The lamellose character of the striæ of growth is distinctly visible in all my specimens.

I have nothing to add to the detailed description of the specimens from the Productus shales of Painkhanda, the Kuling shales of Spiti and the Zewán beds of Kashmir.

*Locality: Number of specimens examined.*—Slopes on left bank of Lissar Valley, 2 miles south of Dharma XI, 2; right side of Bambadhura north glacier, near crossing, Lissar Valley, 2.

### SPIRIFER NITIENSIS, Diener, Pl. IV, figs. 6, 7.

1897. *Spirifer nitiensis*, Diener. The permian fauna of the Productus shales of Kumaon and Garhwál, Palæontologia Indica, ser. XV, Himalayan Fossils, vol. I, pt. 4, p. 41, Pl IV, figs. 4, 5.

1899. *Spirifer nitiensis*, Diener. Anthracolithic Fossils of Kashmir and Spiti, Palæontologia Indica, ser. XV, Himalayan Fossils, vol. I, pt. 2, p. 65, Pl. V, fig. 9.

When introducing this species in 1897, only two specimens were available to me for examination. Recent observations, based upon the study of a large number of examples, have convinced me of the fact, that my type-specimens from Kiunglung E. G., (near the Niti Pass) are extreme shapes, and that a more gradual passage exists between the more typical forms of *Spirifer nitiensis* and *Sp. fasciger* than had been hitherto admitted. The shells composing this species present a wide range of external modifications of detail. Nevertheless the generality of specimens appear to me so distinct from *Sp. fasciger*, that I still feel justified in retaining them as a separate species.

The characters of difference, to which a specific importance has been attributed in the above memoir, are the transversely fusiform shape and the peculiar sculpture, consisting in the unequal strength of the ribs which compose the three fasciculi following immediately on either side of the sinus.

The transversely fusiform shape, recalling *Sp. convolutus*, Phill., is very remarkable in the majority of my specimens, but not without exception. Between the type-specimen figured on Pl. IV of the fourth part of the present volume and the form illustrated on Pl. IV, fig. 6, of this memoir, intermediate shapes form a gradual passage. There are specimens of *Sp. fasciger* known to me, which in their general shape and outlines perfectly agree with this type of *Sp. nitiensis*.

A remarkable character in the overwhelming majority of my specimens is the very broad area. In this respect my type-specimen from Kiunglung is an exception to the generality of examples, in which the area is as broad and markedly reclining as in the types from the Lissar Valley which have been illustrated in this memoir. None of my numerous examples of *Sp. fasciger* shows such a wide area.

The sculpture is exceedingly variable. All my specimens are characterised by the presence of a large number of fasciculi of ribs on each side of the sinus. But the fasciculi themselves are very unequally developed in different specimens. In some individuals dichotomous ribs are entirely absent. In the typical form the central ribs of the three fasciculi, which follow immediately on either side of the sinus, are considerably broader and stronger than the rest, but this rule is subject to numerous exceptions. In those forms which recall *Sp. fasciger* by the very small difference in the strength of the single ribs composing the fasciculi, the coarser character of the ribs is a distinctive feature of importance. A broad median rib in the bottom of the sinus has been noticed in all my specimens. The difference between the coarse and prominent costæ of the visceral portion of the shell and the delicate ornamentation of the wings is very remarkable. The ribs are never sharp but always rounded on the top, the more prominent ones even flatly vaulted.

In the majority of my specimens the strongly protracted sinus elevates the front-margin of the dorsal valve considerably above the general convexity of the latter. In the specimen illustrated on Pl. IV, fig. 7, the frontal wave is unusually large, the sinus projecting in a long, tongue-shaped process above the plane of the valve. The unequal strength of the ribs composing the narrow fasciculi, is clearly exhibited in that specimen, which is partly devoid of shell.

The measurements of the two figured specimens are as follows :—

| | I. | II. |
|---|---|---|
| Entire length of the shell | 41 mm. | 43 mm. |
| Length of the dorsal valve | 33 „ | 35 „ |
| Greatest breadth of the shell | 89 „ | 85 „ |
| Thickness of both valves | 27 „ | 28 „ |
| Breadth of the area of the ventral valve | 12 „ | 10·5 „ |

*Locality: Number of specimens examined.*—Slopes on left bank of Lissar Valley, 2 miles south of Dharma XI, 10; near crest of ridge between Lissar and Dharma Valleys, opposite Kharsa glacier, 2; right side of Bambadhura north glacier near crossing, Lissar Valley, 1.

### SPIRIFER BAMBADHURENSIS, nov. sp., Pl. IV, figs. 8, 9, 10.

In the Productus shales of the Lissar Valley there occurs, besides *Spirifer fasciger* and *Sp. nitiensis*, a third species, which doubtless belongs to the group of *Sp. fasciger* but is distinguished from that species by its remarkable shape. Although represented by numerous examples, it is only imperfectly known to me, all the specimens available for examination being incomplete fragments. It is especially the region of the mesial sinus and of the front, which has not been preserved entire in any of my fragments.

Externally, the species differs considerably from *Sp. fasciger* and its allies by its broadly expanded and obtusely rounded, unattenuated wings, and by the strong curvature of the ventral valve in the transverse direction. In this direction the profile of the valve describes a flatly concave curve, marking a deep depression between the visceral part of the valve and its wings. Just at the apex of the beak a narrow sinus takes its origin, limited on both sides by folds, which are composed of fasciculi of ribs, as in *Sp. fasciger*. The shape of the sinus in the vicinity of the front is not known to me. The beak is prominent, small, pointed and very slightly incurved. It overlooks a very broad, strongly reclining area with an enormous triangular fissure in the middle.

The respective positions of the two valves may be seen from the illustration in fig. 9 *b*. A more complete fragment of a dorsal valve has been represented in fig. 10. It must, however, be borne in mind, that the outlines of this fragment do not agree with the actual outlines of the complete specimen. There was probably no tongue-shaped process of the mesial fold, projecting beyond the front-line, in the latter. So far as one can judge from the direction of the raised striæ of growth, its outlines were most probably of a semi-oval or semi-circular shape, with the length and breadth nearly equal.

The most striking feature of the dorsal valve is the very prominent mesial fold, which rises exactly at the very apex as a sharp crest and continues so for some distance but gradually flattens out towards the frontal region. This valve is also provided with a distinct and proportionately broad, instead of a linear, area.

The ornamentation is nearly the same as in *Sp. fasciger*, Keyserl., but the flatly rounded folds, each of which corresponds to a bundle of rounded ribs of equal strength, are restricted to the vicinity of the sinus. On the lateral parts of the ventral valve the fasciculi of ribs are no longer arranged in flat folds, but are all disposed on the same level. In the majority of specimens the erect lamellose condition of the striæ of growth is as well exhibited as in most examples of *Sp. fasciger*.

No measurements can be given on account of the fragmentary character of my specimens. But the species must have attained very large dimensions, the greatest breadth of the figured ventral valve (fig. 8) being 104 mm., and 120 mm. in a second example.

I should not have proposed a specific denomination for this new, and as yet imperfectly known, representative of the group of *Spirifer fasciger* were it not for its extraordinary shape. But the broadly expanded wings, the remarkable curvature of the ventral valve and the very large reclining area are such striking characters, that they can well serve for a specific distinction from the congeneric forms.

*Locality: Number of specimens examined.*—Right side of Bambadhura north glacier, near crossing, 3; slopes on left bank of Lissar Valley, 2 miles south of Dharma XI, 3.

### SPIRIFER JOHARENSIS, Diener, Pl. V, fig. 12.

1897. *Spirifer joharensis*, Diener. The permian fossils of the Productus shales of Kumaon and Garhwâl, Palæontologia Indica, ser. XV, Himalayan Fossils, vol. I, pt. 4, p. 42. Pl. IV, fig. 3.

In my description of this new species it was suggested that it might probably hold an intermediate position between *Spirifer convolutus*, Phill., and *Sp. niger*, Waagen, and that an Australian species, which had been provisionally referred to *Sp. convolutus* by Etheridge (Quart. Journ. Geol. Soc., 1872, vol. XXVIII, p. 335, Pl. XVII, fig. 3), might be considered as about intermediate between Phillips' carboniferous species and *Sp. joharensis*.

My opinion as to the correctness of placing *Sp. joharensis* in the group of *Sp. convolutus* has been somewhat modified by my recent examination of the materials collected by La Touche in the Productus shales of the Lissar Valley. In typical forms of *Sp. joharensis* the sculpture of the dorsal valve consists of an elevated median fold, which, near the frontal margin, breaks up into four smaller folds, and of thick radial ribs on each side of the medial fold, each of which is accompanied by intercalated smaller ones. Besides dorsal valves with this typical ornamentation, there is one specimen among my materials which in its sculpture indicates a gradual passage into *Sp. nitiensis*, the intercalated costæ uniting with the main ribs in the vicinity of the hinge-line and thus being arranged into narrow fasciculi, the central being generally the most prominent. The high mesial fold retains its sharply rounded crest-shape from the apex to the frontal line, developing gradually minor ribs along its lateral parts. This sculpture differs considerably from that of *Sp. convolutus*, and brings our species into much closer relationship with the group of *Sp. fasciger*, Keyserl.

A sculpture nearly approaching that of *Sp. nitiensis* is also noticed in the fragment of a ventral valve which, from its general characters, must be referred to *Sp. joharensis*. The remaining ventral valves agree perfectly with my type-specimen, which has been illustrated in the above-quoted memoir.

The Australian *Sp. convolutus* (?) from the Bowen river coalfield in Queensland, of which a new illustration has been given more recently by Jack and Etheridge (Geology and Palæontology of Queensland and New Guinea, Pl. X, figs. 10, 11), is too poorly preserved to admit of closer comparison with *Sp. joharensis*.

*Locality: Number of specimens examined.*—Slopes on left bank of Lissar Valley, 2 miles south of Dharma XI, 4; near crest of ridge between Lissar and Dharma Valleys, opposite Kharsa glacier, 2.

### SPIRIGERA (ATHYRIS) GERARDI, Diener, Pl. V, figs. 10, 11.

1897. *Athyris Royssii*, Diener, *ex parte*. The permian fauna of the Productus shales of Kumaon and Garhwál, Palæont. Indica, ser. XV, Himalayan Foss., vol. I, pt. 4, Pl. V, fig. 5 (*non* 7).

1899. *Athyris Gerardi*, Diener. Anthracolithic Fossils of Kashmir and Spiti, *ibidem*, vol. I, pt. 2, p. 56, Pl. VI, figs. 12—14.

When publishing my description and figures of this interesting species, I expressed a regret that the materials then at my command were rather scanty and barely sufficient for a complete diagnosis. Now a large number of well-preserved specimens has been found among La Touche's collections from the Productus shales of the Lissar Valley. Their examination has corroborated the statements which were made in the above-quoted memoir. I am satisfied that I was correct in considering this species as new and distinct from the remaining generic forms on account of the remarkable inequality of its two valves, combined with an uncommonly large apical angle. By this combination of its two leading features it is at once distinguished from *Spirigera Royssiana*, Keyserl., or from *S. subexpansa*, Waag.

The inequality of the two valves is even more strongly marked than was anticipated in my first description of the species. It is a common character in all my specimens. Ventral valves are always exceedingly flat, barely vaulted at all except in the vicinity of the apex. Dorsal valves, on the contrary, are always moderately inflated, and as a rule three or four times as deep as the opposite ones. The valves are generally found separated from each other. I have, however, succeeded in discovering two examples with the valves still attached to each other. Both agree with the type-specimen from Kiunglung (pt. 4 of this volume, Pl. V, fig. 5 *b*) in the respective depths of their valves.

In one of my ventral valves traces of lateral lamelliform expansions, similar to those which adorn the valves of *S. planosulcata*, Phill., or *S. lamellosa*, Lév., have been noticed.

Where the shell has been entirely preserved, it exhibits a very distinct concentric ornamentation, being covered with numerous and closely arranged, delicate, sharp, concentric ridges of unequal strength. In places where the uppermost layer of the shell has been destroyed, these ridges are replaced by delicate lines of growth, which are occasionally crossed by faintly marked radiating striæ. On the casts the radiating sculpture is considerably more pronounced than the concentric ornamentation.

*Locality: Number of specimens examined.*—Slopes on left bank of Lissar Valley, 2 miles south of Dharma XI, 14; near crest of ridge between Lissar and Dharma Valleys, opposite Kharsa glacier, 4.

### DIELASMA LATOUCHEI, nov. sp., Pl. V, figs. 7, 8, 9.

1897. *Dielasma sp. ind.*, Diener. The permian fossils of the Productus shales of Kumaon and Garhwâl. Palæontologia Indica, ser. XV, Himalayan Fossils, vol. I, pt. 4, p. 48, Pl. III, fig. 5.

In the above memoir the poorly preserved ventral valve of a *Dielasma* from the Productus shales of Kiunglung, E. G., was mentioned, and its similarity to *D. Hochstetteri*, Toula, noticed. Abundant materials having been obtained from La Touche's collection, the new species for which his name is proposed, can now be definitely admitted. The majority of the specimens have been partly crushed and more or less deformed, but one specimen in particular was perfectly preserved. This specimen (fig. 7) will be considered as the prototype of the new species.

My type-specimen is of nearly triangular outlines, with obtusely rounded angles and a semicircular, slightly emarginated front-line. It is elongated, flattened and provided with sharp margins. The greatest breadth occurs near the front.

The ventral valve is flattened longitudinally, its arcuation being restricted to the apical region. In the transverse direction its profile presents a triundate curve. In the middle a broadly vaulted longitudinal ridge extends from the apex to the front, where it becomes gradually narrower and less distinct. This median ridge is accompanied on each side by a flatly arched excavation or depression which increases in width towards the front, where it corresponds to the two projecting lobes of the slightly biplicate front-line. Above these excavations or depressions the marginal regions of the valve are considerably elevated. In young specimens all these characters are but faintly developed.

The beak is thick, short and very slightly incurved, truncated by a very large foramen, which pierces the apex of the valve. On its lower side a small deltidium is distinctly developed. From both sides of the foramen sharp ridges originate, and descend in a graceful curve towards the lateral parts of the valve, thus forming a narrow false area.

The dorsal valve is nearly straight, barely vaulted at all in the longitudinal direction, and indistinctly biplicate. Each lobe in the front-margin corresponds to a flatly rounded fold which rises in the vicinity of the apex. Between these folds a broad valley or depression is included. In the majority of examples the folds and intervening valley or groove are faintly developed, but never more distinctly than in my type-specimen.

Both valves are covered with numerous striæ of growth, which are, however, never very conspicuous.

The measurements of my type-specimen are as follows:—

| | |
|---|---|
| Entire length of the shell | 48 mm. |
| „ breadth „ „ | 42 „ |
| Length of the dorsal valve | 44 „ |
| Thickness of both valves | 13·5 „ |

My largest example has a length of 61 mm.

Of internal characters, the presence of two dental plates in the ventral, and of a strong median septum in the dorsal, valve has been stated.

In the specimen illustrated in fig. 9 the striated muscular platform of the dorsal valve is partly exposed. It agrees almost perfectly with the illustration given by Hall and Clarke on Pl. LXXXI, fig. 37, of their Introduction to the genera of Palæozoic Brachiopoda (Palæontology of New York, vol. VIII, 1894).

*Locality: Number of specimens examined.*—Slopes on left bank of Lissar Valley, 2 miles south of Dharma XI : 18.

*Remarks.*—In my memoir on the fauna of the Productus shales of Kumaon and Garhwál the similarity of this species to ***Dielasma Hochstetteri***, Toula, (Ueber einige Fossilien des Kohlenkalkes von Bolivia, Sitzungsber. Kais. Akad. d. Wiss. Wien, 1869, LIX, fig. 1) from the coal-measures of Cochabamba has been noticed. The examination of a large number of full-grown individuals has, however, convinced me that the similarity of the two species is only comparatively slight. Both agree in the presence of elevated marginal regions in the ventral valve, but in ***D. Hochstetteri*** the ventral valve is provided neither with a mesial ridge nor with an emarginated front-line, nor has it the triangular shape of ***D. La Touchei.***

There is, however, a Russian species which seems to be more nearly allied to the present one than ***D. Hochstetteri.*** This is ***D. uralicum***, Krotow, (the Artinskian stage, Mem. Soc. of Naturalists, Imper. University of Kasan, vol. XIII, pt. 5, 1885, p. 287, and Mem. Comité géol. St. Petersbourg, 1888, vol. VI, p. 429, Pl. I, figs. 33—36) from the upper carboniferous limestone of Tscherdyn-Ssolikamssk and from the Artinskian beds of Eastern Russia. Krotow's species agrees with ***D. La Touchei*** in the triangular shape, in the presence of elevated margins and of a mesial ridge in the ventral valve, and of a corresponding depression in the opposite valve. They differ in the following characters: ***Dielasma uralicum*** is considerably smaller and more strongly inflated. The mesial ridge in the ventral valve is very broad and high and causes the front-margin to ascend in a tongue-shaped process.

If we accept the classification of ***Dielasma*** proposed by Waagen, we find the present species uniting the characters of the two groups of the ***D. truncatum***, Waagen, and of ***D. biplex***, Waag. Among the group of ***D. truncatum, D. itaitubense***, Derby (Bulletin Cornell University, Ithaca, 1874, vol. I, No. 2, p. 1, Pl. II, figs. 1, 3, 8, 16; Pl. III, fig. 24; Pl. VI, fig. 15), resembles it closely in the curvature of the valves and in the presence of sharp margins, originating at the apical foramen and limiting off a distinct false area. With the group of ***D. biplex*** it has the biplicate character of the shell in common. Among the representatives of this group it recalls ***D. problematicum*** by the development of a mesial ridge which is bordered by an excavated depression on each side.

From all the congeneric species of the Salt Range Productus limestone *D. La Touchei* is easily distinguished by its triangular shape; the coincidence of the greatest breadth of the shell with the angles of the front and lateral margins is also a good feature of distinction.

## CONCLUSIONS.

The fauna of the Productus shales of the Lissar Valley, as contained in the materials collected by La Touche, comprises the following species:—

*Pleurotomaria* cf. *punjabica*, Waag.
*Naticopsis*, sp. ind.
*Bellerophon*, sp. ind.
*Chonetes* cf. *uralica*, Mœller.
*Productus* cf. *gangeticus*, Dien.
    „ sp. aff. *Purdoni*, Dav.
*Marginifera himalayensis*, Dien.
*Spirifer rajah*, Salt.
    „ cf. *Ravana*, Dien.
    „ *fasciger*, Keyserl.
    „ *nitiensis*, Dien.
    „ *bambadhurensis*, nov. sp.
    „ *joharensis*, Dien.
*Spirigera* (*Athyris*) *Gerardi*, Dien.
*Dielasma La Touchei*, nov. sp.

Although the number of species—amounting to 15, of which 12 are specifically determinable—is considerably larger than that of the forms which were known to me in 1897 from Griesbach's collection, very little is added to our knowledge of the stratigraphical character of the fauna of the permian Productus shales of Kumaon.

One of the most interesting facts is the discovery of rocks which are full of fossil remains of *Marginifera himalayensis*, Dien., and *Spirifer rajah*, Salt. Rocks of an identical lithological character and with the same association of species are common in the Kuling shales of Spiti, where they have been recorded in Part 2 of this volume from Kuling, Muth and Lilang, but had as yet not been known to occur in Kumaon and Garhwál. Their occurrence is a strong argument in favour of a correlation of the Kuling and Productus shales, if any more arguments should be needed in addition to those based on an examination of the stratigraphical condition of both rock-groups.

The result of my examination of La Touche's collection is a good illustration of the fact that the Brachiopoda of the Productus shales are not distributed indiscriminately throughout this formation, but that some forms seem to have only a very limited local range.

In Part 4 of this volume (p. 4) I have alluded to the absence of *Productus cancriniformis*, Tschern., and *Spirigerella Derbyi*, Waag., in the Productus shales of the Lissar Valley, whereas these two species are exceedingly common in the same beds of the Niti area. The total absence of *Chonetes lissarensis*, Dien., in La Touche's collection is still more striking. In Griesbach's collections from a locality south of Dharma XI, which cannot be far from the place visited by La Touche, several slabs of rock were made up entirely by the casts of this shell. Of this, the commonest leading fossil in Griesbach's collection, not a single specimen was found in La Touche's collection, which, on the other hand, contained an enormous number of ***Marginifera himalayensis*** and of ***Spirifer rajah***, Salt., which were both absent from the materials available to me in 1897.

The character of this fauna is as peculiar as that of the typical Productus shales in the Niti area of Painkhanda. Out of 12 species, which have been specifically determined, 9 are autochthonous and have not hitherto been found outside the Himalayas. Of the three remaining species, *Spirifer fasciger* is ubiquitous and ranges from upper carboniferous into permian strata, *Chonetes uralica* is quoted from upper carboniferous and Artinskian deposits, and *Pleurotomaria punjabica* is met with in all divisions of the Salt Range Productus limestone.

## IV.—FOSSILS FROM THE PERMIAN PRODUCTUS SHALES OF BYANS.

During the hot season of 1899 Mr. F. H. Smith was deputed to Byans and the Kuti-Yangti Valley. Collections were made by him in the Productus shales of Nihal, Kaua Malla, Kalapani and Lilinthi. The state of preservation of the fossils is rather poor. The following species have been determined :—

### *Nihal.*

*Pleurotomaria*, sp. ind.
*Productus cancriniformis*, Tschern.
*Marginifera himalayensis*, Dien.
*Chonetes lissarensis*, Dien.
*Spirifer fasciger*, Keyserl.
„ cf. *Ravana*, Dien.

Rock-specimens from a calcareous band in the Productus shales below Peak 13,944 above Nihal were found to be full of shells of *Chonetes transitionis*, Krotow, associated with *Leda* cf. *speluncaria*, Gein., two species of the permian system in Europe.

### *Kaua Malla.*

*Marginifera himalayensis*, Dien.
*Dielasma* cf. *La Touchei*, Dien.

### *Kalapani.*

*Goniomya*, sp ind.
*Liebea* sp. ind. ex aff. *L. Hausmanni*, Goldf.
*Productus* cf. *Purdoni*, Dav.
*Marginifera himalayensis*, Dien.
*Chonetes lissarensis*, Dien.
*Spirifer fasciger*, Keyserl.
„ *rajah*, Salter.

### *Lilinthi.*

*Hyattoceras* nov. sp. ex aff. *H Cumminsi*, White.
*Adrianites* (*Hofmannia*), sp. ind.
*Gastrioceras*, sp. ind. ex aff. *G. Marianum*, Vern.
*Pericyclus*, sp. ind.
*Lilinthiceras*, nov. gen. sp. ind.
*Brancoceras* sp. ind.
*Nomismoceras Smithii*, nov. sp.
*Marginifera himalayensis*, Dien.
*Spirifer fasciger*, Keyserl.
*Spirigera* cf. *Gerardi*, Dien.

The most interesting result of my examination of Mr. Smith's Himalayan collection is the discovery of a permian fauna of ammonites in the Productus shales of Lilinthi. This fauna was chiselled out from a few slabs of rock and consists of only very small specimens. Notwithstanding the scarcity of materials available for examination, seven genera have been recorded. But it is to be regretted that no more complete list of this fauna can be given, a larger collection of fossils from the cephalopoda-bearing beds of Lilinthi being most desirable.

The following pages contain a description of the fossils collected by Mr. F. H. Smith in the Productus shales of Byans.

## CEPHALOPODA.

### **Hyattoceras** nov. sp. ex aff. **H. Cumminsi**, White, Pl. V, fig. 20.

The genus *Hyattoceras* was proposed in 1887 by Gemmellaro (La Fauna dei calcari con Fusulina della valle del F. Sosio, Fasc. I, p. 14) for a small number of species of *Arcestidæ* from the permian Fusulina limestone of Sicily which, although agreeing with the triassic genus *Arcestes* in their general shape, differ from the latter by the peculiar character of their sutural line.

In 1889 an ammonite from the permian rocks of Baylor and Archer counties in Northern Texas was described as *Ptychites Cumminsi* by Ch. White (American Naturalist, 1889, vol. XXIII, p. 117, Pl. I, figs. 4—8). In 1891, Prof. White (The Texan permian and its mesozoic types of fossils, Bull., U. S. Geol. Survey, No. 77, Washington, 1891, p. 20, Pl. I, figs. 4—8) transferred this species to Gemmellaro's new genus *Waagenoceras*, emphasizing its close relationship with *W. Stachei* from the permian rocks of Sicily. In his memoir on the geological results of the examination of the Salt Range Fossils from the Productus limestone, Prof. Waagen (l. c., p. 203) takes an entirely different view of the systematic position of *Ammonites Cumminsi*. "It can only be compared," he says, "to the *Hyattoceras* of Sicily, but deviates from the Italian species of the genus by a remarkably strongly developed lower lateral ramus of the siphonal lobe."

I prefer to follow the view adopted by Waagen. The Sicilian species included in the genus *Hyattoceras* by Gemmellaro are all, it is true, provided with involute whorls and with a very small umbilicus, whereas in *Ammonites Cumminsi* the whorls "are so deeply embracing as to form small, narrow umbilici, which show a small portion of each of the inner volutions" (White). Thus in general shape and involution the American species more strongly recalls the genus *Waagenoceras* than *Hyattoceras*, but, on the other hand, the arrangement of its sutural line peremptorily forbids its being placed among the representatives of *Waagenoceras*.

The configuration of the sutures being the most important character for a distinction in doubtful cases, there is no question regarding the intimate affinity of *Ammonites Cumminsi* to *Hyattoceras*. In view of the tendency prevailing among modern palæontologists, in favour of a narrower circumscription of single species and genera, it might perhaps be desirable to consider this species as the prototype of a proper sub-genus, differing from *Hyattoceras* by its less involute whorls and by the presence of an open, funnel-shaped umbilicus. It appears to me, however, that a sub-generic distinction on the strength of such characters of detail is not sufficiently justified, and I consequently cannot plead for a separation of *Ammonites Cumminsi* from the genus *Hyattoceras*.

The name *Hyattoceras* has been changed into *Hyattites* by Frech (Die Dyas, Lethæa palæozoica II, 3 Abth., p. 478). There is no reason to follow this procedure, which is in contradiction to the rules of palæontological nomenclature.

To the group of *Hyattoceras Cumminsi* belongs a new species from the Kuling shales of Lilinthi. The only specimen available for description is of very small size, but nevertheless provided with a considerable part of its body-chamber, which exceeds one-half of the last volution in length. The shell is strongly inflated, with slowly increasing whorls, which do not overlap each other completely, as in the Italian species of *Hyattoceras*, but leave the inner volutions partly exposed within the moderately large and deep umbilicus.

The transverse section is cordiform. The largest transverse diameter is equal to the height of the volution and nearly coincides with the umbilical margin. The umbilical margin is regularly rounded, the lateral parts being bent in a graceful and very regular curve towards the umbilical suture. The siphonal area is equally rounded and passes gradually into the lateral parts, without forming an edge.

*Dimensions :—*

| | |
|---|---|
| Diameter of the shell | 7 mm. |
| ,, ,, ,, umbilicus | 1·5 ,, |
| Height of the last volution | 3·8 ,, |
| Thickness of the last volution | 4 ,, |

*Sutures.*—The most remarkable character of this species is its sutural line. Besides the siphonal lobe there are three lobes and four saddles visible, before the suture reaches the umbilicus, towards which they gradually decrease in size and complexity. Although preserving the general arrangement of the sutural elements peculiar to *Hyattoceras*, the lobe-line differs from all the hitherto known species of this genus in its minor details. The most conspicuous character in *H. Cumminsi* is the development of a very large and deep siphonal lobe with a high median prominence. In the present species the siphonal lobe is rather short, less deep than the principal lateral lobe, and provided with a small median prominence only. It agrees, however, with the American species in the development of a lateral branch in the external border of the siphonal saddle. The lateral lobes are tripartite at their base. Their ramifications are asymmetrically arranged along their marginal walls.

The saddles are more slender than in *H. Cumminsi* and provided with few but deep incisions of a phylloid shape. The phylla next in height to the terminal phyllum in each of the lateral saddles are situated on the umbilical side of the marginal walls, whereas in the siphonal saddle the phylla on the external border are the highest.

The auxiliary series consists of one lobe and saddle only. This is a smaller number of auxiliary elements than in any of the hitherto described species of *Hyattoceras*, owing probably to the insignificant size of the Himalayan specimen.

*Locality: Number of specimens examined.*—One mile north-west of Lilinthi: 1.

### ADRIANITES (HOFFMANNIA), sp. ind., Pl. V, fig. 26.

A single, tolerably well-preserved specimen from the Kuling shales of Lilinthi, seems to belong to this genus. It is of very small dimensions and consists of air-chambers only. The septa do not stand very close together. It may consequently be suggested that the full-grown individual exceeded the present fragment considerably in size.

Among the species of *Adrianites* described by Gemmellaro from the permian Fusulina limestone of Sicily, this specimen most nearly resembles *Adrianites Hoffmanni*, Gemmellaro (La fauna dei calcari con Fusulina della valle del F. Sosio, p. 49, Tav. VII, figs. 1—5). There is a striking similarity in the system of sculpture, which in *A. Hoffmanni* differs remarkably from the ornamentation observed in the remaining congeneric species.

In its general shape my Himalayan specimen differs from *A. Hoffmanni* by its more involute whorls, which increase more rapidly in width and height. The Sicilian species has the umbilicus much wider and more open, and is more discoidal. The whorls are strongly inflated, and have an almost circular cross-section. The last volution embraces not more than one-fifth of the preceding one. As many as three volutions are known. The lateral parts are regularly arched and pass into the strongly curved siphonal area and umbilical shoulders without any distinct demarcation, whereas in *A. Hoffmanni* the siphonal and lateral parts of the shell are separated by a rounded marginal border.

The sculpture consists of numerous radial ribs which are rounded above and perfectly straight. They rise exactly in the umbilical suture and are strongest in the lower portion of the lateral parts. Half-way from the umbilical shoulders to the ventral area of the shell either the majority of ribs become dichotomous, or else weaker ribs are intercalated between the principal ones. All the ribs continue, although in considerably reduced strength, across the siphonal area without any interruption. The direction of the siphonal ribs, which are nearly twice as numerous as the lateral, is perfectly straight. This ornamentation makes our specimen a most typical representative of Gemmellaro's sub-genus *Hoffmannia.*

Constrictions are seen on the cast to the number of three in the last volution. They cross the ribs in a very oblique angle, being slightly curved forward in the vicinity of the siphonal area.

*Dimensions:*—

| | | |
|---|---|---|
| Diameter of the shell | | 8 mm. |
| " " umbilicus | | 3 " |
| Height | of the last volution | 4 " |
| Thickness | | 4 " |

*Sutures.*—The most remarkable character in the arrangement of the sutural line is the unusually large size of the siphonal prominence, which in height surpasses the siphonal saddle. It is bottle-shaped and provided with a small incision on its apex. This is exactly the shape of the siphonal prominence (à forma di bottiglia e inciso sull' apice) which Gemmellaro considers to be a typical feature in his genus *Agathiceras.*

In his beautiful memoir on the ammonites of the Artinskian stage (Mémoires Acad. Impér. des sciences de St. Pétersbourg, ser. VII, vol. XXXVII, 1889, p. 64), Karpinsky, however, demonstrated the small importance of this character. He, in accordance with E. v. Mojsisovics, even included *Adrianites* in *Agathiceras,* not even giving sub-generic rank to the former. Although, having regard to the peculiarities of its sculpture, the present species must be compared to *Adrianites Hoffmanni,* it is more nearly allied to *Agathiceras* in the development of its sutures. Apart from its higher median prominence, the sutural line of my Himalayan specimen is very similar to that of *Agathiceras uralicum,* Karp., or of *A. Krotowi,* Karp., as figured by Karpinsky (l. c., Taf. IV, fig. 4 *d,* Taf. V, fig. 7 *c*).

I have counted three lateral lobes and only two saddles corresponding to a diameter of 5·5 mm., whereas in *A. Krotowi* a third lateral saddle is present corresponding to a diameter of 6 mm. The lateral lobes regularly decrease in size towards the umbilical suture. In some of them there is a well-marked tendency to change their evenly rounded base into a lanceolate shape with angular borders. The saddles are slender, with parallel sides and regularly arched tops, and nearly twice as broad as the adjoining lateral lobes.

*Locality: Number of specimens examined.*—One mile north-west of Lilinthi: 1.

## GASTRIOCERAS, sp. ind. ex aff. G. MARIANUM, Vern., Pl. V, fig. 23.

The single, imperfect fragment by which this genus is represented in the Himalayan collection belongs to the group of *Gastrioceras Jossæ,* de Verneuil, and *G. Marianum,* de Vern., which is characterized by moderately evolute whorls, a trapezoidal cross-section, and strong umbilical ribs. As the fragment is absolutely insufficient for a specific determination, I prefer to abstain from giving a detailed description, and merely record its presence in the Productus shales of Lilinthi.

From the Sicilian representative of the genus it differs strongly by the complete absence of spiral striæ on the marginal portion of the flanks and on the siphonal area. It, however, retains the strong constrictions which are so common in the majority of species of *Gastrioceras* and *Glyphioceras.*

The figure 23 *c* on Pl. V shows the sutures to be characteristic of *Gastrioceras.* They strongly resemble those of small specimens of *G. Marianum* as given by Karpinsky (l. c., Taf. IV, fig. 2). The sutures of my specimen, corresponding to a diameter of 3 mm., are distinguished from the sutures of adult individuals by a rounded siphonal lobe with a very short median prominence and by a flatly curved lateral lobe, which appears inclined to become pointed in later stages of growth. The marginal wall of the siphonal saddle is more steeply inclined than the umbilical one. The lateral saddle is broadly rounded.

*Locality: Number of specimens examined.*—One mile north-west of Lilinthi: 1.

### BRANCOCERAS (?), sp. ind., Pl. V, fig. 24.

It is only with great hesitation that I venture to include in this genus the single fragmentary specimen available for examination. In shape it is more similar to most species of *Glyphioceras,* being broadly rounded and involute, with a semilunular cross-section, not compressed and discoidal as in typical forms of *Brancoceras.* This character is, however, of minor importance, my specimen consisting only of air-chambers, and not exceeding a height of 4 mm. in the last volution. In a typical species of *Brancoceras—Goniatites Belvalianus,* de Koninck (Faune du calcaire carbonifère de la Belgique, II, p. 95, Pl. 50, figs. 8—10)—the original shape is thickly globose and the compressed volutions are only acquired in later stages of growth. The inner volutions of the specimens by which the present species is represented, may consequently be very different in their shape from the full-grown individuals. Thus its globose character is not sufficient argument in favour of removing my Himalayan specimen from *Brancoceras* and placing it in the genera *Glyphioceras* or *Gastrioceras.*

The lateral parts of the low and broad whorls are strongly curved and unite in the regularly rounded siphonal area without distinct demarcation. The greatest transverse diameter corresponds to the sharply defined umbilical edge. The deep umbilicus is surrounded by a perpendicular wall.

The sculpture consists of numerous radial ribs, which cross the rounded siphonal area, where they are most strongly developed. *Brancoceras ornatissimum,* de Kon., is provided with a similar sculpture. In the latter species, however, the ribs form a broad sinus on the ventral portion of the shell, whereas in the Himalayan specimen they are not falciform but nearly straight, as in some species of the genus *Pericyclus,* Mojs.

*Dimensions* :—

| | |
|---|---|
| Diameter of the shell | 8 mm. |
| ,, ,, ,, umbilicus | 2 ,, |
| Height of the last volution | 4 ,, |
| Thickness of the last volution | 6 ,, |

*Sutures.*—The most important character of this specimen is its sutural line which shows a broadly rounded and simple siphonal lobe, a regularly rounded lateral lobe, rounded siphonal and lateral saddles, and a very small auxiliary lobe and saddle, both situated on the umbilical wall.

The external sutures of a typical *Brancoceras* consist of an undivided, pointed or rounded ventral lobe, one pair of angular lateral lobes and a second pair of rounded lobes on the umbilical border. The lateral saddles are more broadly rounded than the siphonal saddles. From this arrangement of the sutural line in typical species of *Brancoceras* the sutures of the present specimen differ chiefly by the rounded shape of the lateral lobes. This difference does not appear to me a sufficient reason to forbid an identification of our specimen with *Brancoceras*. My view is chiefly based on a comparative study of the ontogeny of *Glyphioceras* by Perrin Smith (Proceedings of the California Acad. of Sciences, 3rd ser., Geol., vol. I, San Francisco, 1897, pp. 105—126). Perrin Smith agrees with the majority of authors in considering *Prionoceras*, Hyatt, as the ancestor of the *Glyphioceratidæ*. It has been demonstrated by K. v. Zittel and by Holzapfel, that *Brancoceras* and *Prionoceras* merge one into the other, and that there is no reason for retaining the two as independent genera. Now *Glyphioceras incisum*, according to the instructive studies of Perrin Smith, in its ontogeny goes through the stages of *Anarcestes*, *Tornoceras* and *Prionoceras*, showing a gradual change from *Prionoceras* to *Glyphioceras* in the adolescent and early adult stages. The end of the *Prionoceras* stage is reached in this species at two and three-fourths of a whorl, corresponding to a diameter of the shell of 2·25 mm.

This development of the sutural line is clearly exhibited in Pl. XX accompanying Perrin Smith's memoir. The sutural line, as illustrated in figs. 6 and 7, perfectly agrees with the sutures of our Himalayan specimen, the ventral and lateral lobes being regularly rounded at their base. It is only at a diameter of the shell of 1·64 mm. that they assume the angular shape developed in adult individuals of *Brancoceras*. Thus I am not inclined to consider the angular shape of the lobes as a character of generic importance in *Brancoceras*. I am consequently obliged to place a species with rounded lobes, such as is represented by our Himalayan specimen, in the latter genus.

A species with very similar sutures from the permian Fusulina limestone of Sicily has been referred to *Brancoceras* by Gemmellaro (La fauna dei calcari con Fusulina della Valle del F. Sosio, Appendice, Palermo, 1886, p. 26). The examples by which this species, *Brancoceras pygmæum*, Gemm., is represented, are of very small size, and consist of air-chambers only. Frech (Die Dyas, Lethæa palæozoica II, 2 Abth., p. 475) does not consider the absence of a median prominence in the siphonal lobe to be satisfactorily proved, but attributes the species to the genus *Gas-*

*trioceras*, entirely denying the presence of *Brancoceras* in strata younger than lower carboniferous. In this opinion A. Holzapfel also concurs, so far as the geological distribution of *Brancoceras* is concerned, which he believes to be restricted to beds of upper devonian and lower carboniferous age.

The only difference of importance between *Brancoceras* and *Glyphioceras* or *Gastrioceras* is the presence of a simple, undivided siphonal lobe in the first genus, whereas this lobe is provided with an often strongly developed median prominence in the two latter genera. In my specimen the ventral portion of the sutural line has been perfectly well preserved. Thus there cannot be any doubt as to the absence of a siphonal prominence. In *Glyphioceras incisum* the end of the *Prionoceras* or *Brancoceras* stage is reached at two and three-fourths of a whorl, corresponding to a diameter of 2·25 mm. It is consequently impossible to consider the present specimen, with a diameter of 8 mm., as a specimen of *Gastrioceras* or *Glyphioceras* which has not yet passed from the adolescent *Brancoceras* or *Prionoceras* to the adult stage of *Gastrioceras* or *Glyphioceras*.

The determination of the present specimen, which, though not beyond doubt, has much probability of correctness, demonstrates the possibility of an extension of the genus *Brancoceras* into strata of permian age.

*Locality: Number of specimens examined.*—One mile north-west of Lilinthi: 1.

### NOMISMOCERAS SMITHII, sp. nov., Pl. V, fig. 25.

An incomplete specimen of *Nomismoceras*, with part of its body-chamber preserved, approaches in its outlines *N. vittigerum*, Phill. In its ornamentation it recalls *N. Meneghinii*, Gemmellaro (La Fauna dei calcari con Fusulina della Valle del F. Sosio, Fasc. I, p. 92, Tav. X, figs. 39—43), but its less evolute shape alone is sufficient to separate the two species.

The shell is strongly compressed and of discoidal shape. The inner volutions increase very slowly and their transverse section is nearly circular, even in the penultimate whorl. The last volution, however, increases more rapidly and overlaps the penultimate whorl to nearly one-half of its height. Thus a comparatively narrow umbilicus is formed. The umbilicus is considerably smaller than in the Sicilian species and slightly smaller than in *Nomismoceras vittigerum*, Phill., and *N. rotiforme*, Phill., but yet much larger than in *N. ornatum*, Foord and Crick. With *N. Meneghinii* my Himalayan species agrees in the shape of the cross-sections. In the inner volutions the siphonal part is broadly vaulted, but becomes more compressed towards the aperture, thus imparting a strongly lenticular shape to the profile of the last volution. Both the siphonal and umbilical margins are regularly rounded, without any distinct demarcation.

The deeply marked constrictions which are so common in the families of *Glyphioceratidæ* and *Gephyroceratidæ* are seen in my specimen to the number of two on the last volution.

In its ornamentation the Himalayan species recalls *N. Meneghinii* and *N. gracile*, Gemm., from the permian Fusulina limestone of Sicily. The innermost volutions are probably smooth, but their state of preservation does not permit this diagnosis to be given with full certainty. The outer whorls, especially the last, are covered with numerous sharp ribs, which originate above the umbilical suture and are separated by equidistant valleys. The ribs increase in number towards the siphonal margin either by bifurcation or by intercalation of new ones. They are perfectly straight on the lateral parts of the shell. The main ribs cross the siphonal area without changing their direction, but such minor ribs as originate by bifurcation in the vicinity of the siphonal area are turned backward while crossing the siphonal part. There is, however, no sharp bend visible in the direction of the ribs, as in the two Sicilian forms.

The measurements of the specimen are as follows :—

| | |
|---|---|
| Diameter of the shell | 8 mm. |
| ,, ,, umbilicus | 2 ,, |
| Height } of the last volution | 4·5 ,, |
| Thickness } of the last volution | 3 ,, |

*Sutures.*—The sutures are simple, with elements entirely rounded. The lobes stand at equal heights. The siphonal lobe is divided by a small median prominence, the details of which have, however, been destroyed by weathering; it is followed by a high, straight, external saddle. This external saddle is regularly rounded above and bordered by parallel margins. The lateral saddle is considerably smaller, rounded above and bordered by sloping margins. A small umbilical lobe is situated outside the umbilical suture.

In the arrangement of its sutures my Himalayan species is very nearly allied to *N. vittigerum*, Phill. A comparison with the sutural line of the latter species, as illustrated by Haug (Études sur les Goniatites, Mémoires Soc. géol. de France, 1898, No. 18, p. 45, fig. 11), clearly shows this similarity. The only difference consists in the slightly deeper position of the siphonal lobe and in the converging margins of the adjoining principal saddle.

*Locality: Number of specimens examined.*—One mile north-west of Lilinthi: 1.

*Remarks.*—I do not think there can be any difference of opinion as to the genus to which the present species should be attributed. It agrees in all its characters of importance with *Nomismoceras*, Hyatt, if this genus is admitted in the interpretation of Holzapfel and Haug.

The genus *Nomismoceras* was established by Hyatt, who erroneously placed it among the family of *Glyphioceratidæ*. Holzapfel (Die Cephalopoden führenden Kalke des unteren Carbon von Erdbach-Breitscheid, Palæontologische Abhandl. von Dames u. Kayser, V, p. 32) emended the genus and included in it flat, discoidal and evolute species with a wide umbilicus, which in their outlines recall the genus *Prolecanites*, Mojs., of which *Goniatites spirorbis*, Phill. (Geology of Yorkshire, II, T. 20, figs. 51—55), is regarded as the prototype. Its sutural line is very simple. All the lobes are rounded. The broad siphonal lobe is divided by a median prominence. The external saddle is broad and low, the lateral lobe broad and very flat, barely reaching the height of the median prominence, and situated close to the umbilical margin. A lateral saddle is but faintly indicated.

Foord and Crick (Catalogue of the fossil Cephalopoda in the British Museum, Pl. III, 1897, p. 217), and Haug also, retained *Nomismoceras* with full generic rank, although it had originally been merged in *Glyphioceras* by K. v. Zittel (Handbuch der Palæontologie, Abth. I, Bd. II, p. 420). Haug, to whom we owe a thorough study of the relations of *Nomismoceras* to both *Glyphioceras* and *Gephyroceras*, gives the following diagnosis of the first genus: Body-chamber shorter than the last volution, inner whorls very slowly increasing, barely overlapping each other, with circular cross-section; outer volutions often more rapidly increasing and overlapping each other considerably, with lenticular or biangular transverse sections; lobes entirely rounded, siphonal prominence low, saddles broadly rounded; lateral saddle distinctly individualized, second lateral lobe corresponding to the umbilical suture.

In all these characters my Himalayan species agrees so perfectly with the diagnosis given by Haug, that its position in the genus *Nomismoceras* is fairly certain. In adopting the latter genus in Haug's interpretation, I must consequently follow Haug and Frech (Lethæa palæozoica, II, Bd. 3, Lfg. "Die Dyas," p. 475) in refuting Gemmellaro's identification of *Nomismoceras gracile* and *N. Meneghinii* with *Glyphioceras*. In these two species, which have been compared to *N. Smithii* as regards their ornamentation, the slowly increasing whorls, which barely overlap each other, are retained in later stages of growth. Their sutural lines are much like those of *N. vittigerum*.

The intimate relationship of *Paralecanites*, Diener, from the permian Bellerophon limestone of the South-Eastern Alps with *Nomismoceras*, as suggested by Haug, is very probably correct. It is certainly much more plausible than Frech's identification of *Paralecanites*, Dien., with *Paraceltites*, Gemm. The distinctive features in the arrangement of the sutural line, especially the angular shape of the siphonal lobe, appear to me, however, sufficiently well-marked to retain the subgeneric denomination for the Alpine ammonites.

### PERICYCLUS, sp. ind., Pl. V, fig. 21.

The genus *Pericyclus* has been introduced by E. v. Mojsisovics (Cephalopoden der Mediterranen Triasprovinz, Abhandl. Geol. Reichs-Anst., X, p. 141) for the accommodation of *Goniatites princeps*, de Kon., and *G. virgatus*, de Kon., which were considered by him as ancestors of his triassic genera *Acrochordiceras*, *Halorites* and *Juvavites*. As revised by Holzapfel (Die Cephalopoden führenden Kalke des unteren Carbon von Erdbach-Breitscheid, Palæontologische Abhandl. von Dames und Kayser, V, p. 83) the genus comprises trachyostraca, involute forms with sutures as in *Glyphioceras* but with a very characteristic sculpture, consisting of strong, transverse ribs, which cross the rounded siphonal part. The genus has hitherto been known only from strata of lower carboniferous age in Belgium, Germany, Great Britain and Indiana.

Among my materials from the Productus shales of Byans three fragments of outer volutions must probably be attributed to ***Pericyclus***. Their ornamentation is so characteristic that I do not hesitate to identify them with this genus, notwithstanding their incomplete state of preservation.

From their outlines we are led to suppose that the fragments belonged to moderately inflated, strongly involute forms with rounded whorls, corresponding to the group of *P. Kochi*, Holzapfel. In my largest fragment the cross-section of the whorl is of equal height and width. Both the lateral and umbilical margins are regularly rounded. The surface is adorned with numerous slightly sigmoidal ribs which cross the siphonal part without interruption. The ribs are not sharp, but rounded, on their tops. Some of them slightly increase in strength before passing across the siphonal area. Most of the ribs bifurcate in the umbilical region, as in *P. furcatus*, M'Coy (Synopsis of the characters of the carboniferous fossils of Ireland, p. 21, Pl. IV, fig. 13), but the ribs are more numerous and less gibbous than in the Irish species.

All my specimens being fragments of the body-chamber, the sutural line is not known to me.

*Locality : Number of specimens examined.*—One mile north-west of Lilinthi : 3.

### LILINTHICERAS, nov. gen. sp. ind., Pl. V, fig. 22.

It seems rather hazardous to propose the new genus for the accommodation of a single, not entirely preserved ammonite, whose sutural line is not known to me. If one wished to be rigorous in the introduction of new genera and to accept only those of which a fairly complete diagnosis can be given, the present one would certainly not be among those which could be retained without contradiction. But the present species is of such interest, on account of its similarity to triassic forms, that I feel obliged to distinguish it by a proper generic designation notwithstanding its incomplete state of preservation. I must, of course, abstain from giving an exact diagnosis of this new genus. Its leading features are obvious from a description of the present species, which occupies an isolated position among permian ammonites on account of its peculiar, strongly trachyostrac sculpture.

My type-specimen is of small size, like all the ammonites in Smith's collection from Lilinthi. It is provided with its body-chamber, to which the anterior portion of the last volution belongs. It is of obliquely elliptical shape, but it is impossible to decide whether this shape ought to be considered as original or is rather due to an accidental deformation in the matrix. The discoidal shell consists of slowly increasing whorls, which barely overlap each other. The transverse section of the last whorl is of equal height and width, broadly rounded above, but with distinctly marked umbilical edges, which are separated by a low, but steeply inclined wall, from the umbilical suture.

The most peculiar character of the species is its strongly marked sculpture. This sculpture is interrupted along the median line of the siphonal area. On each side of the median line a row of small tubercles is arranged, which gradually passes over into narrow ribs. In crossing the siphonal margin the ribs are adorned with a second set of tubercles. Thus two spiral rows of tubercles are found, one of them situated on the siphonal area and the other on the lateral parts in the vicinity of the siphonal margin. From the row of marginal tubercles the ribs are continued as strong and bulky costæ to the umbilical edge, where traces of tubercles are faintly indicated.

The sutural line is but very imperfectly known to me. The presence of a rounded siphonal, and a large lateral, saddle and corresponding lateral lobe, has been ascertained.

The measurements of this specimen are as follows :—

| | | |
|---|---|---|
| Diameter of the shell | | 11 mm. |
| " " umbilicus | | 4 " |
| Diameter of the shell | at the place of its greatest aplanation | 2 " |
| " " umbilicus | | 6 " |
| Height | of the last volution | 4 " |
| Thickness | | 4 " |

*Locality: Number of specimens examined.*—One mile north-west of Lilinthi : 1.

*Remarks.*—There is a striking similarity between the present species and some of the upper triassic representatives of the genus *Clionites*, Mojsisovics (Die Cephalopoden der Hallstätter Kalke, Abhandl. K. K. Geol. Reichs-Anst. VI, 2 Th., p. 451). *Clionites Ares*, Mojs., very nearly approaches *Lilinthiceras* in its general shape and sculpture, omitting the difference which exists in the elliptical outlines of the Himalayan species. They agree in the development of bulky ribs, which are interrupted along the median line of the siphonal area and are adorned by a marginal and siphonal row of tubercles. This external similarity is, however, no argument in favour of a direct affinity of *Lilinthiceras* with *Clionites*. The two genera are too far distant in their geological age, to give any clue as to their true relationship. It is much more probable that their external similarity is only one of the many phenomena of convergence, which are so often noticed in ammonites of different geological horizons.

## GASTEROPODA.

### PLEUROTOMARIA, sp. ind.

Two fragments of casts agree so exactly in their shape and sculpture with *Pleurotomaria*—in the interpretation of Koken—not of L. de Koninck—that I can scarcely entertain a doubt that they belong to that genus. They are, however, absolutely insufficient for specific identification, being badly weathered casts, with their umbilical regions entirely destroyed. They might, perhaps, be included in the group of *Pleurotomaria punjabica*, Waag., yet better preserved specimens might show the Himalayan species to be really different from the Salt Range form.

*Locality: Number of specimens examined.*—Nihal : 2.

## LAMELLIBRANCHIATA.

### LEDA cf. SPELUNCARIA, Geinitz, Pl. V, fig. 13.

1848. *Nucula speluncaria*, Geinitz. Versteinerungen des deutschen Zechstein, gebirges, p. 9, Taf. IV, fig. 6.
1850. *Nucula Vinti*, King. Monogr. permian foss. of England, Palæont. Soc., p. 176, Pl. XV, figs. 21, 22.
1862. *Leda speluncaria*, Geinitz. Die Dyas, p. 68, Taf. XIII, figs. 25–31.
1885. *Leda speluncaria*, Tschernyschew. Der permische Kalkstein im Gouvernement Kostroma, p. 15, Taf. XVI, fig. 16.
1886. *Leda speluncaria*, Krotow. The Artinskian stage (Russian), Trudy Soc. of Nat. Imper. Univers. of Kasan, vol. XIII, pt. 5, p. 248.
1894. *Leda speluncaria*, Netschajew. Die Fauna der permischen Ablagerungen des œstlichen Theiles des europæischen Russlands, *ibidem*, vol. XXVII, pt. 4, p. 251.

The only specimen, which I attribute with some reserve to this common species of the German Zechstein, is a cast without any trace of its shell. The narrow posterior wing has not been entirely preserved. Notwithstanding its fragmentary character the specimen agrees so exactly with specimens from the Zechstein of Gera in the collection of the Palæontological Museum of the Vienna University that there can be very little doubt as to its identity with *Leda speluncaria*.

My specimen is of medium size. Its backward shifted umbo is situated near the anterior third of the entire length of the shell. Traces of the cardinal teeth are noticed in the anterior portion of the hinge-line. Indistinct furrows, which reach from each umbo to the pallial line, at the same time curving towards the posterior end, are faintly indicated. The muscular impressions are not accessible to observation.

The measurements of this specimen are as follows :—

| | |
|---|---|
| Entire length of the shell | ca. 15 mm. |
| „ height „ „ | 8 „ |
| Thickness of both valves | 5·5 „ |

*Locality: Number of specimens examined.*—Calcareous band in the Productus shales, Nihal, immediately below Peak 13,944 : 1.

### GONIOMYA, sp. ind., Pl. V, fig. 19.

It seems rather hazardous to quote this genus in a permian fauna. Notwithstanding Krotow's statement to the contrary, *Goniomya*, by the generality of palæontologists, is not accepted as occurring in strata older than mesozoic. Both K. v. Zittel (Grundzuege der Palæontologie, p. 305) and W. Dall (in Zittel's Textbook of Palæontology, p. 389) quote the liassic and cretaceous periods as limits of the vertical distribution of the genus *Goniomya*. It would, however, be very difficult to decide in what genus the shell here under consideration ought to be placed, as in all its external characters it resembles so closely a jurassic *Goniomya*. The ovato-trapezoidal outlines and the V-shaped sculpture of the gaping valves are such peculiar features, that I do not hesitate to class my Himalayan specimen with Aggassiz's genus, although this identification is based on external similarity only, and not founded upon any examination of the internal characters, which are, unfortunately, not accessible to observation.

My specimen is too fragmentary to merit special description. Of palæozoic species only a single one, *Goniomya artiensis*, Krotow (The Artinskian stage, Trudy, Soc. of Naturalists, Imper. University of Kasan vol. XIII, pt. 5, 1885, p. 255, Pl. III, fig. 20), from the Artinskian strata of Russia, can be compared to it. But from this Artinskian species my Himalayan shell is readily distinguished by the different position of the median line of the V-shaped sculpture, which in *G. artiensis* is shifted considerably nearer to the posterior end of the shell. Thus the two species are certainly not identical.

*Locality: Number of specimens examined.*—Kalapani; 1.

### LIEBEA sp. ind. ex aff. L. HAUSMANNI, Goldf., Pl. V, fig. 18.

Several specimens of a large bivalve have given much trouble from the state of their preservation, which is unsatisfactory, but they appear to correspond better with the characters assigned to the genus *Liebea* by Waagen than to any other. The shape of the strongly inequivalve shell appears to be much the same as in *L. Hausmanni*, Goldf., and the steep bending down of the anterior lateral margins from the beaks is perfectly well exhibited in all my fragments.

Of my specimens the figured one, which is the most complete, shows the two valves attached to each other. They are of mytiliform shape, strongly inequilateral and moderately inflated. The left valve is the larger. Its pointed beak is slightly incurved and projecting above the partly injured apex of the smaller but more strongly inflated right valve. The beaks are anterior in their position and attenuated. In the shape of the apical angle this specimen recalls *Liebea squamosa*, Sow., rather than *L. septifer*, King, if King's division of *L. Hausmanni* into two proper species is accepted. From the vaulted median line in the apical region the lateral parts are more steeply inclined in the anterior than in the posterior direction. The presence of wings cannot be stated, because the shell is injured at the place where they ought to be situated. The short hinge-margin is straight and bordered by a distinct, sharply defined area in each valve.

The surface is covered in both valves by numerous concentric ridges of very unequal strength.

Exact measurements cannot be given, as the materials at hand are too fragmentary. The figure will give, I hope, a sufficiently clear idea of the leading features of the illustrated specimen. What can be made out of the latter is not contradictory to an identification of the fossil as a species of *Liebea*, allied probably to *L. Hausmanni*.

*L. Hausmanni* has been characterised by Geinitz (Dyas, p. 72, Taf. XIV, figs. 8—16) in an excellent manner, and from his description it can easily be seen that the German and Himalayan species are certainly not identical. The characters by which the two species can be distinguished are the remarkable difference in their size, and the more strongly inflated shape of the right valve in my Indian shell. In its dimensions the latter somewhat recalls the Australian genus *Aphanaia*, de Koninck (Recherches sur les foss. paléozoiques de la Nouvelle Galles du Sud, p. 302), but in this genus, which, like *Liebea*, externally recalls *Inoceramus* or *Aucella* of mesozoic age, the right valve is always the larger.

*Locality: Number of specimens examined.*—Kalapani : 3.

## BRACHIOPODA.

### PRODUCTUS cf. PURDONI, Davidson.

1862. *Productus Purdoni*, Davidson. Quart. Journ. Geol. Soc., London, XVIII, p. 31, Pl. II, fig. 5.

For further synonyms my memoir on the fossils of the Productus shales of Kumaon and Garhwál (Pt. 4 of the present volume, p. 21) may be consulted.

It is with considerable hesitation that I introduce this as a species from the Productus shales of Byans. Several very large but badly preserved *Producti* have been collected by Smith near Kalapani. One example is probably referable to this species. The specimen, though worn and fragmentary, consists of both valves. Its strongly elongate outlines, the comparatively short hinge-line, and the presence of two small wings in the dorsal valve, which are separated from the remainder of the valve by diverging furrows, essentially ally it to *P. Purdoni*. A small cardinal process and a very long and stout median septum are observable in the dorsal valve.

In its dimensions this specimen nearly agrees with the larger of the two examples which have been illustrated on Pl. II of the above memoir.

*Locality: Number of specimens examined.*—Kalapani: 1.

### PRODUCTUS CANCRINIFORMIS, Tschernyschew.

1889. *Productus cancriniformis*, Tschernyschew. Allgemeine geologische Karte von Russland, Bl. 139. Beschreibung des Central-Urals und des Westabhanges, Mém. Com. géol. St. Pétersbourg, vol. III, No. 4, p. 373, Pl. VII, figs. 32, 33.

For a more complete list of synonyms I refer to my memoir on the permian fauna of the Productus shales of Kumaon and Garhwál (Part 4 of the present volume), p. 31.

To these synonyms the following should be added :—

1900. *Productus cancriniformis*, Schellwien. Die Fauna der Trogkofelschichten in den Karnischen Alpen und den Karawanken, Abhandl. K. K. Geol. Reichs-Anst., XVI, Bd. Heft. 1, p. 43, Taf. IX, figs. 1—3.

Numerous examples of this leading fossil of the Productus shales of Kiunglung E. G., in the Niti district were collected by Smith at Nihal, together with *Chonetes lissarensis*, Dien. The specimens, although imperfect—the majority being ventral valves—completely agree with the types illustrated in my above-quoted memoir. One of them is a little larger than any of the hitherto known Himalayan examples, and agrees in its dimensions and outlines with Tschernyschew's Artinskian type-specimen from the Ural Mountains.

Whereas among the Niti forms longitudinally oval shapes predominate, the types from Byans are, as a rule, broader than long. In several specimens traces of a mesial sinus are faintly indicated. In one example a sinus is sufficiently well developed to justify a reference of this type to Schellwien's *var. sinuata* (l. c., p. 44, Taf. IX, figs. 4—6).

Great variation in sculpture has been noticed by Schellwien in his permocarboniferous examples from Carniola. He especially remarks that in some of his specimens the concentric wrinkles are so faintly developed that an identification with *Productus cancrini*, Vern., was earnestly taken into consideration. All my numerous specimens of *P. cancriniformis* from the Niti district were distinguished from *P. cancrini* by the presence of wrinkled transverse folds, extending from the wings and lateral margins across the entire shell. But among my materials from Byans there are some examples in which the concentric wrinkles are but faintly indicated and restricted to the median portion of the shell. In this respect and in the development of a mesial sinus, they agree completely with Schellwien's types from the permocarboniferous rocks of Neumarktl in the south-eastern Alps.

*Locality: Number of specimens examined.*—Nihal: 11.

### MARGINIFERA HIMALAYENSIS, Diener, Pl. V, fig. 27.

This is the chief leading fossil of the Productus shales of Byans. All the numerous shapes which have been described from Kashmir, Spiti and the Lissar Valley, were also obtained from Smith's Himalayan collection.

One specimen has been found in which the internal arrangement of the dorsal valve is fairly well exhibited. Its internal characters are nearly the same as those of *M. typica*, which have been excellently illustrated by Waagen (Salt Range Foss., Palæont. Indica, ser. XIII, vol. I, Prod. limest. Foss., p. 718). The lower portion of the cardinal process has been partly broken off, but the long median septum, which forms its continuation on the inner side of the valve, is clearly visible. On both sides of the median septum the inner pair of reniform adductor impressions is distinctly developed. The brachial ridges bordering these adductor or occlusor impressions proceed obliquely outwards; then turning abruptly backwards terminate in a hook-shaped process at a considerable distance from their origin. Impressions of the outer pair of adductor muscles are not preserved.

Otherwise I can add nothing to my description of this species in the foregoing chapter and in the second part of the present volume.

*Locality: Number of specimens examined.*—Kalapani, 64; one mile north-west of Lilinthi, 34; one mile east of Kalapani, 18; Nihal, 20; Kaua Malla, 6.

### CHONETES LISSARENSIS, Diener.

1897. *Chonetes lissarensis*, Diener. The fauna of the permian Productus shales of Kumaon and Garhwál Palæontologia Indica, ser. XV, Himalayan Fossils, vol. I, pt. 4, p. 19, Pl. II, figs. 4—6.

1899. *Chonetes lissarensis*, Diener. Anthracolithic Foss. of Kashmir and Spiti, *ibid.*, pt. II, p. 46, Pl. VI, fig. 3.

A small number of ventral valves in Smith's Himalayan collection are referable to this species. None of them is actually perfect, but, so far as can be judged from their state of preservation, they closely resemble my illustrations of *Chonetes lissarensis*. They have the trapezoidal outlines with rounded margins, and the very sharply impressed mesial sinus with a narrow median fold along the base which are the chief characters of distinction in this easily recognised species.

Of the shell no trace has been preserved.

*Locality: Number of specimens examined.*—Nihal, 3; one mile east of Kalapani, 2.

### CHONETES TRANSITIONIS, Krotow, Pl. V, figs. 14—17.

1885. *Chonetes transitionis*, Krotow. The Artinskian stage (Russian), Mém. Soc. of Naturalists, Imper. University of Kasan, vol. XIII, pt. 5, p. 273, Pl, IV, figs. 12—15.

1889. *Chonetes transitionis*, Tschernyschew. Allgem. geol. Karte von Russland, Bl. 139. Beschreibung des Central-Urals und des Westabhanges Mém. Com. géol. St. Pétersbourg, III, No. 4, p. 377, Pl. V, fig. 9.

This Artinskian species is represented in the Himalayan collection by a large number of specimens. Both ventral and dorsal valves, with their shell entirely preserved, are available for examination. Thus a fairly complete diagnosis of the species can be given, which will considerably add, I hope, to the rather short descriptions which have been published by Krotow and by Tschernyschew.

The shell is of variable size and outlines. It is always broader than long. But in the majority of specimens the difference between length and breadth is inconsiderable, whereas in a few specimens the width of the shell is nearly double its length. The outline is transversely rectangular, with semicircular margins. The majority of the specimens are provided with small but distinctly developed auriculate wings, which terminate in sharply pointed cardinal angles. But these slightly produced wings are occasionally missing, in which case the cardinal angles are rounded off acutely. The same variability in the character of the cardinal terminations has been noted by Krotow in his Artinskian types. The majority of Himalayan representatives of this species correspond to the Russian types illustrated on Pl. IV, figs. 13, 14, of Krotow's memoir, whereas the type illustrated in fig. 12 is an exception.

The ventral valve is either flatly or moderately curved. The curve is regular in the longitudinal direction, but in the transverse direction is regular only on the visceral and lateral parts of the valve. Towards the wings the shell is strongly flattened. The demarcation between the strongly curved visceral and the flattened marginal portions in the vicinity of the wings is more or less distinctly defined. In some exceptional shapes it is even marked by a sharp furrow.

The straight hinge-line is always as long as the greatest breadth of the shell. It is bordered by a very narrow area, which is divided by a small deltidial fissure. On the cardinal margins, limiting the area above, five to six spines are noticed on each side of the pointed beak, which is scarcely prominent, and does not overlie the hinge-line.

In the majority of examples no trace of a mesial sinus is indicated. Sometimes, however, the ventral valve is slightly depressed along the middle, in which case there is a slight corresponding emargination in the front line. In none of my specimens is a sinus more distinctly developed than in the Artinskian type illustrated by Krotow on Pl. IV, fig. 13, of his memoir.

The most remarkable feature of the ventral valve is its delicate ornamentation. It consists of very numerous, radiating lines, which are crossed by more distant concentric striæ.

The dorsal valve is distinctly concave, following the curve of the opposite valve. In different specimens this valve assumes a greater or lesser degree of concavity, with, at times, an indistinct longitudinal elevation along the middle, and flatness near the cardinal extremities. In the ornamentation of its surface it is similar to the ventral valve.

The internal characters of the species are not known to me.

The measurements of two specimens are as follows :—

| | I. | II. |
|---|---|---|
| Entire length of the shell . . . . | 7·5 mm. | 7·5 mm. |
| ,, breadth ,, ,, (along the hinge-line) . | 11 ,, | 13 ,, |
| Thickness of the ventral valve . . . . | 3 ,, | 3·5 ,, |

*Locality : Numer of specimens examined.*—Nihal : 20.

*Remarks.*—I think there can be but little doubt as to the correctness of an identification of my Himalayan shell with Krotow's Artinskian species, as they agree completely, even in details of minor importance, so far at least as one may judge from illustrations, without the type-specimens themselves being available for comparison.

*Chonetes transitionis* belongs to a group of forms which are characterized by the absence of a distinctly developed sinus and by their peculiar ornamentation. The combination of a radiating and concentric sculpture, as represented in this species, does not allow the latter to be placed in any of the groups which have been proposed by L. de Koninck, Davidson and Waagen. A new group of *striato-concentricæ* should be introduced for it.

### SPIRIFER RAJAH, Salter.

This species is represented in Smith's collection by a cast of a ventral valve only, but possessing the subcircular outlines and the coarse, fasciculate ribs which are among the leading features of *Spirifer rajah*. In the face of such characters I cannot but refer the fragment to that species.

*Locality : Number of specimens examined.*—One mile east of Kalapani : 1.

### SPIRIFER cf. RAVANA, Diener.

A weathered and crushed specimen of a large *Spirifer* with a sharply impressed sinus and radial striation, in which traces of fasciculation are but faintly indicated, may be provisionally referred to this species. The identity with the latter is, of course, only very vague. In making use of the term *Sp. Ravana*, I feel that it is merely a name employed to distinguish a weathered specimen, having a fancied resemblance to that species, but which might with equal right have been referred to *Sp. Marcoui*, Waag.

*Locality : number of specimens examined.*—Nihal : 1.

### SPIRIFER FASCIGER, Keyserl.

In the Productus shales of Byans numerous fragments of this species have been noticed. The fragment of a ventral valve from Nihal, with its apical region entirely preserved, is sufficiently complete to permit of identification.

From the same locality the species is known to me in the condition of very large internal casts, closely resembling those described and figured by myself in the second part of the present volume (pl. V, fig. 7) from the Kuling shales of the Spiti Valley.

*Locality : number of specimens examined.*—Nihal, 4 ; Kalapani, 1 ; Lilinthi, 2.

### SPIRIGERA cf. GERARDI, Diener.

The external impression of a ventral valve from Lilinthi is referable to this species. It exhibits the outlines of a *Spirigera* with a very large apical angle and a flatly curved profile. The unsatisfactory state of preservation, however, renders an exact determination impossible.

### DIELASMA cf. LA TOUCHEI, Diener.

The fragment of a small *Dielasma* from the Productus shales of Kaua Malla is probably referable to this species. It possesses an elongately triangular outline, with the greatest breadth shifted towards the front margin, which meets the lateral margins in rounded-off angles. Along the median line of the valve a low ridge is faintly indicated, to which a narrow depression corresponds in the opposite valve.

Without venturing for a moment to deny, in the face of such features, that the present species is really identical with *Dielasma La Touchei*, this identification appears nevertheless somewhat doubtful. What remains of the apical region leads one to suppose that it was very strongly inflated, much more so than in my type-specimens from the Productus shales of the Lissar Valley. But the present specimen is evidently too imperfect for it to be possible to ascertain anything regarding its original shape. It is consequently impossible to decide whether it should be definitely referred to *Dielasma La Touchei*.

## V. FOSSILS FROM THE ANTHRACOLITHIC SYSTEM OF SPITI.

Spiti is classic ground for Himalayan geology. The anthracolithic system of this region was studied and described by F. Stoliczka[1] in 1864 and by C. L. Griesbach in 1889. The following sequence of beds has been established by C. L. Griesbach[2]:—

A white quartzite of about 500 feet in thickness, which corresponds to the white quartzite of probably carboniferous age in the eastern sections of Garhwál and Kumaon, is conformably overlaid by a grey, flaggy limestone (8*a*, Griesbach), which is especially well developed in the vicinity of Muth. Above this grey limestone follow the Kuling shales (*sensu stricto*), consisting of sandstones and shales, which have yielded a fauna of permian age and are the equivalent of the Productus shales of the Niti district.

In the materials entrusted to me for description in 1897, which had been collected by Dr. Gerard, Stoliczka and Griesbach, only the Kuling shales (*sensu stricto*)—namely, the beds included between the grey limestone of Muth (8*a*) and the Otoceras-stage—were represented by fossil remains, with one single exception. This exception was a species collected by Stoliczka near Kuling in a limestone of unknown age. I identified this species with *Syringothyris cuspidata*, Mart., and consequently inferred the presence of a horizon of lower carboniferous age in the vicinity of Kuling. This view, however, has been rendered untenable by subsequent survey work in Spiti.

The fossils from the Kuling shales (*sensu stricto*) have been described in the second part of the present volume, and were found to indicate a permian age for that group. Thus Griesbach's correlation of the Kuling shales of Spiti with the permian Productus shales of Johár and Painkhánda, which had been based chiefly on stratigraphical and lithological characters, was corroborated by palæontological evidence.

Survey work in Spiti was taken again in hand in the years 1898 and 1899. In the summer of 1898, Mr. H. H. Hayden worked out in detail the sequence of the older beds in Spiti, paying special attention to the palæozoic group. A short summary of his results was published in the General Report for 1898-1899 (pp. 46—50). In May 1899 Mr. Hayden returned to Spiti accompanied by Dr. A. v. Krafft. Nearly the whole district was mapped by the two officers, the sequence of beds examined in as great detail as the time available would permit, and a large collection made from several fossiliferous horizons of the anthracolithic series. The material described in the present memoir consists of the anthracolithic fossils from Hayden's and A. v. Krafft's collections.

---

[1] *F. Stoliczka*, Geological sections across the Himalayan Mountains from Wangtu bridge on the river Satlej to Sungdo on the Indus, Mem. Geol. Surv. of India, vol. V, pt. 1, pp. 25—29.

[2] *C. L. Griesbach*, Geology of the Central Himalayas, *ibidem*, vol. XXIII, 1891, pp. 212—223.

Mr. H. Hayden gave the results of his observations in Spiti in a paper which was published in the general Report for 1899-1900 (pp. 189—199). The following is a summary of the chief points concerning the stratigraphical features of the anthracolithic system.

In the development of this system two "facies" may be distinguished. In the "southern facies"—Muth section—the unfossiliferous white quartzite is overlaid by a few hundred feet of grey, flaggy limestone (8*a*, Griesbach), which is separated from the overlying permian Kuling series by a thin bed of conglomerate. Within the Kuling series (*sensu stricto*) two rock-groups can be distinguished, a lower calcareous sandstone and an upper group of shales, which yielded Ammonites of the genera *Cyclolobus* and *Xenaspis*. These shales are considered as identical with the Productus shales of Johár and Painkhánda. The Cephalopoda-bearing horizon is said to be situated thirty feet below the Otoceras beds.

In the "eastern facies" the grits and conglomerates underlying the calcareous sandstones at the base of the Kuling shales increase in thickness and pass down into several thousand feet of alternating shales and quartzites. Neither the white quartzite nor the overlying limestone of Muth (8*a*, Griesbach) are seen. The series attains an enormous development in the lower Spiti Valley, its total thickness being not less than 3,000 feet.

Fossils occur at three horizons, situated at about 500, 1,000 and 1,500 feet respectively below the Kuling or Productus shales. The two upper horizons have been called "Fenestella beds" by Hayden on account of the large number of *Bryozoa* abounding chiefly in the uppermost horizon. The Fenestella beds consist of dark slates, and have been correlated provisionally with the Zewán or Bárus beds of Kashmir by Hayden. The lowest horizon, which is best exposed in the vicinity of Thabo, consists of dark-grey and black shales, and contains numerous plant remains.

The most characteristic feature in the anthracolithic system of Spiti is the presence of an unconformity, occurring at the base of the calcareous sandstone, which everywhere immediately underlies the Productus shales.

"This unconformity has been traced throughout the whole length of Spiti and Northern Bashahr. In Spiti the characteristic facies of the upper palæozoic is the southern of Stoliczka, *viz.*, the white (Muth) quartzite overlain by a relatively small thickness of grey limestone, upon which the permian sandstone rests unconformably. At the head of the Thanam Valley the limestone gradually disappears and the sandstone lies on the white quartzite, which, however, as the outcrop is followed from west to east, also dies out, and so on with the underlying beds until the permian sandstone is found resting with apparent conformity on the red silurian quartzite. Higher beds then gradually re-appear, and at the Hangrang pass, between Sungnam and Hango, the sandstone rests on the lower beds of the upper silurian limestones. North of Hango the white (Muth) quartzite is again seen in small patches, gradually increasing in thickness, till above Lio in the valley of the Lipak river, what appears to be a complete section of the carboniferous and permian beds is found.

The section up to the top of the Muth quartzite is perfectly normal; then follow in *ascending* order—

(*a*) Grey limestone (8*a*, of Griesbach).
(*b*) Alternating beds of limestone, shale and quartzite, with a hard, thin bed of conglomerate.
(*c*) Thick mass of hard, dark limestone, with some flaggy sandstones and slates.
(*d*) Shales and quartzites (the eastern facies).
(*e*) Conglomerates and grits passing up into calcareous sandstone (permian).
(*f*) Productus shales.

"This is probably the most complete section of carboniferous and permian beds yet known in the Himalayas, and the total thickness from the base of the Muth quartzite to the base of the Productus shales is certainly not less than 5,000 feet."

Among the materials collected by H. Hayden and A. v. Krafft fossils are represented from the grey, flaggy limestone near Muth (8*a*, Griesbach), from the plant-bearing shales near Thabo, from the Fenestella beds of Po and of the Losar Nullah, from the calcareous sandstone and from the Kuling (Productus) shales. The fossils from Hayden's sub-division *c* are, as a rule, too badly preserved to allow a specific determination. But some of them strongly resemble forms from the grey limestone (8*a*).

As at least two faunæ—one from the horizons below the great unconformity, and the other from the calcareous sandstones and shales above that unconformity—can be separated with precision, I have resolved to describe the fossils from these two main divisions of the anthracolithic system quite separately. I shall have again occasion to refer to this subject when discussing the problem of correlation of the different groups of this system as established by Hayden.

## A. FOSSILS FROM THE LOWER DIVISION OF THE ANTHRACOLITHIC SYSTEM.

[BELOW THE GREAT UNCONFORMITY—GREY, FLAGGY LIMESTONE (8*a*), AND FENESTELLA BEDS.]

### LAMELLIBRANCHIATA.

The materials collected by H. Hayden and A. v. Krafft are so scanty and so imperfectly preserved that no idea of the real character of the bivalve-fauna can be formed. With rare exceptions, one fragmentary specimen only is available for the description of a species. In none of them are the characters of generic importance

---

[1] *Hayden* in "General Report" for 1899-1900, p. 188.

accessible to observation. Thus I must be satisfied with determinations which can only indicate approximately the real affinities of the shells. Another reason which renders the majority of fragmentary examples unfit for determination is their marked difference from any species hitherto described. As they probably belong to new species, I have purposely excluded them from a special description, because their imperfect state of preservation does not render them worthy of a specific denomination.

From the flaggy limestone of Muth (8*a*, Griesbach) an indeterminable fragment of ***Pecten*** or *Aviculopecten* has been collected by A. v. Krafft. The list of Lamellibranchiata from the Fenestella shales is a little larger. From this horizon the following forms may be quoted:—

### AVICULOPECTEN sp. ind. ex aff. A. HIEMALI, Salter, Pl. VII, fig. 22.

This species is represented by a single, fragmentary left valve, the wings of which have been partly broken off.

In its shape and sculpture it exhibits a remarkable similarity to *Aviculopecten hiemalis*, Salter, and its allies. It is only very slightly inequilateral, and considerably longer than high. The apex is roughly median in its position, well incurved, distinctly prominent and pointed. The apical angle is considerably smaller than in *A. hiemalis* and much more so than in *A. Kokscharofi*, Vern. The marginal edges, separating the apical region of the shell from the wings, form a distinctly emarginated curve; this is especially so in the case of the anterior margin, which slopes as a perpendicular wall towards the surface of the corresponding wing.

Of both wings only small fragments have been preserved. The character of the marginal edges, separating them from the apical region of the shell, unites with the broadly curved ventral margin in a sharp angle.

In its ornamentation the present species appears to be so closely allied to *Aviculopecten hiemalis*, that differences can only be noticed in the minor details. Three different classes of ribs may be distinguished, according to their length and strength. The ribs of the third class are more regularly intercalated between those of the first and second classes than in *A. hiemalis*. The concentric sculpture is only very delicately marked. The ribs are perfectly smooth and devoid of any nodular elevations.

The measurements of the present specimen are as follows:—

| | |
|---|---|
| Entire length of the shell . . . . . . . . | . 34 mm. |
| „ height „ „ . . . . . . . | . 28 „ |
| Thickness of the left valve . . . . . . . . | . 8 „ |
| Apical angle . . . . . . . . . . | . 74° |

*Locality: number of specimens examined.*—Losar Nullah: 1. (Coll. Hayden and Krafft.)

*Remarks.*—The fragmentary state of the wings does not permit me to determine satisfactorily the affinities of the present species to *A. hiemalis*. The difference in the apical angle and in some details of minor importance precludes such an identification. In my memoir on the fauna of the permian Productus shales of Garhwál and Kumaon (pt. 4 of the present volume, p. 12) the relations existing between *A. hiemalis*, Salter, *A. Kokscharofi*, Vern., *A. Draschei*, Toula, *A. Bouéi*, Vern., and *A. ægyptiacus*, Walther, have been fully discussed. All these species can put in a claim for closer comparison with the present form, though the latter is certainly not identical with any of them.

### AVICULOPECTEN sp. ind. (?) aff. A. MORAHENSIS, Waagen.

A fragment of the ventral portion of a single right (?) valve exhibits in its sculpture a marked resemblance to *Aviculopecten morahensis*, Waagen (Salt Range Fossils, Palæont. Indica, ser. XIII, vol. I, Productus Limest. Foss., p. 308, Pl. XXIII, fig. 8), from the middle division of the Salt Range Productus limestone. The ornamentation consists of sharp, radiating costæ of unequal strength, which are crossed by very numerous lamellæ forming ogival or zig-zag vaults on the roof-shaped folds.

*Locality: number of specimens examined.*—North of Po: 1. (Coll. Hayden.)

### MYALINA sp. ind. aff. RECURVIROSTRIS, Meek and Worthen, Pl. VII, fig. 23.

There is a strong resemblance between the right valve of a mytiliform shell from the Fenestella beds of Po and some carboniferous species of the genus *Myalina*, de Koninck. My specimen corresponds in its general outlines with those bivalves for which L. de Koninck proposed the above generic name in 1842. It is a little longer than high, obliquely elongate, narrowed anteriorly, expanded posteriorly. Beak acute and corresponding to the anterior termination of the hinge-line. Anterior margin obliquely truncated, with a small sinuosity in front. Posterior margin arcuate, uniting with the ventral margin in a regular curve. Ventral margin short and rounded. An ill-defined elevation extends from the umbo to the ventral margin.

The surface is ornamented with numerous concentric, imbricating ridges.

The identification of this specimen with *Myalina* is by no means certain, the cardinal apparatus not being known to me. The remarkable flatness of the shell is not, however, opposed to this identification, the right valve being always the flatter in inequivalve species of *Myalina*, as in *M. recurvirostris*, Meek and Worthen (Geol. Survey of Illinois, vol. II, Palæontology, p. 344, Pl. 26, fig. 9). It is to the right valve of this species, from the upper coal measures of Illinois, that the present shell seems to be most nearly allied. The remarkable curvature in the apex of the American species is restricted to the left valve.

*Locality: number of specimens examined.*—North of Po: 1. (Coll. Krafft.)

### POSIDONOMYA, sp. ind.

I find great difficulty in referring several indistinct casts, having a strongly marked concentric ornamentation, to their proper genera. One specimen from Po seems to agree pretty well in its characters with *Posidonomya*. The flat shape and circular outline, the absence of wings, and the small size of the slightly elevated beak, speak strongly in favour of this identification. *Posidonomya constricta*, L. de Koninck (Faune du calcaire carbonifère de la Belgique, Annales, Musée d'hist. nat. de Belgique, T. XI, pt. V, p. 182, Pl. XXXI, figs. 19, 20), is probably a nearly allied species.

*Locality: number of specimens examined.*—North of Po: 1. (Coll. Hayden.)

## BRACHIOPODA.

### PRODUCTUS LINEATUS, Waagen, Pl. VII, fig 1.

In my memoir on the fauna of Chitichun No. I (pt. 3 of the present volume) *Productus cora*, d'Orb, and *P. lineatus*, Waagen, have been adopted in the sense in which these names have been employed by the Russian geologists. The classification of species belonging to the group of *P. cora*, has been recently discussed by Schellwien (Abhandl. K. K. geol. Reichs-Anst., XVI, 1900, p. 41), who came to the conclusion that neither the presence of a sinus nor of spines can be considered as specific characters of distinction, as had been suggested by Waagen.

Transitional forms between *P. lineatus* and *P. cora* were discovered by myself in the Chitichun fauna and recorded likewise in the permocarboniferous fauna of the Eastern Alps by Schellwien. The presence of transitional forms between the spine-bearing *P. lineatus*, Waagen, and *P. Neffedievi*, Vern., without spines, has been recorded by Nikitin in his memoir on the upper carboniferous fauna of the gshelian stage (Mém. Com. géol., 1890, vol. V, No. 5, p. 158). Nor is the absence of spines a common character in all types of *P. Neffedievi*, Vern., and *P. corrugatus*, M'Coy, of lower carboniferous age, notwithstanding Waagen's statement to the contrary. L. de Koninck (Monographie des genres *Productus* et *Chonetes*, p. 52), in uniting *P. corrugatus* and *P. Neffedievi* with *P. cora*, specially remarks that in the latter types spines are not altogether absent, and that one of his specimens from the mountain limestone of Ratingen was covered with even a larger number of spines than d'Orbigny's type-specimen of *P. cora* from Yarbichambi in Bolivia.

Thus a separation of species belonging to the group of *P. cora*, d'Orb., based on the absence or presence of a sinus and of spines, is no longer tenable. Nevertheless Schellwien recommends the distinction of some well-characterized local varieties by special names. Whether a specific or only a varietal rank ought to be granted to such types, is a question of minor importance.

Among all the varieties of the group of *P. cora* none is better marked than *P. lineatus*, if this name is restricted to Waagen's type-specimens from the Salt Range Productus limestone. These types are distinguished by their strongly enrolled apical region, by their elongate outlines, and by their square transverse section, with a flattened median and very steep lateral parts. If the species is taken with this definition, as proposed by Schellwien, neither the fossils from Mjatschkowo, which have been figured by Trautschold, nor any of my Chitichun types can be placed among its synonyms. If we adhere strictly to Schellwien's definition—and this, indeed, I consider the only way to avoid confusion—barely one single name can be left in the long list of synonyms enumerated by Waagen and by myself in the third part of the present volume (p. 14).

In the anthracolithic system of Spiti, the true *P. lineatus* is represented by a large and well-preserved specimen, in which all the leading features of the Salt Range species are excellently developed. This specimen is considerably longer than broad, strongly enrolled and square in section. The transverse section of its visceral portion is almost quadrangular. The flat median part and the perpendicular lateral parts unite in sharply curved angles. A shallow impression along the median line of the visceral region gradually disappears in the vicinity of the front. Small wings were probably present in the unbroken specimen, but have been broken off in the fossil. The strongly incurved beak is distinctly bent over the straight hinge-line.

The surface of the ventral valve is covered by very numerous and radiating striæ. The striæ are all straight and very regular, thus differing remarkably from the irregular ornamentation noticed in *P. tenuistriatus*, Vern., and also in some varieties of *P. cora*. Spines are entirely absent in my specimen. Not even in the vicinity of the hinge-line is there any indication of spines or tubercles.

Of the dorsal valve the impression of the cast has been preserved, but not in its regular position attached to the ventral valve. It is concave in the visceral portion, with an impressed apical region and a moderately prominent, though flatly arched, median fold. In the vicinity of the margins the valve is distinctly geniculated. From its outlines the presence of a large trail in the opposite valve is obvious. The ornamentation consists of radiating striæ, which augment by bifurcation, or by intercalation of new ones, and are crossed by less numerous, but sharply marked concentric lines. These concentric lines are most strongly developed on the wings, which, however, in our specimen are only fragmentarily preserved.

The measurements of my specimen are as follows:—

| | |
|---|---|
| Length of the ventral valve in a straight line . . . . | 57 mm. |
| " " " " along the curve . . . . | 100 " |
| Breadth of the ventral valve . . . . . . | ca. 50 " |
| Thickness " " " . . . . . . . | 30 " |
| Length } of the dorsal valve . . . . . . . | { 26 " |
| Breadth } | { 35 " |

*Locality and geological position: number of specimens examined.*—Grey, flaggy limestone (8*a*), 203 feet above base of the white quartzite, north-west of Muth: 1. (Coll. Krafft.)

*Remarks.—Productus lineatus*, if taken in the sense attributed to this form by Schellwien, is a species of a narrower geographical distribution than *P. cora*. It has been quoted by Waagen from all divisions of the Salt Range Productus limestone, where, according to Noetling, it is commonest in the "zone of *Productus lineatus*" of the upper Productus limestone (Chideru group of Noetling). According to Tschernyschew the species is also represented in the Uralian Schwagerina limestone of upper carboniferous age.

### PRODUCTUS sp. ind. (group of SEMIRETICULATI).

In A. v. Krafft's and Hayden's collections there are numerous specimens of a large species of *Productus* belonging to the group of *semireticulati*, but unfortunately they are all casts of dorsal valves only. They are either flattened or slightly concave in the visceral region but abruptly curved, parallel to the opposite valves, in front. A mesial ridge is only faintly indicated. The valves are of about equal length and width and provided with a hinge-line which is considerably shorter than the greatest breadth of the valve.

The surface is ornamented with numerous radiating ribs, which increase in number by dichotomy, and become considerably coarser near the margins. This system of radiating costæ is crossed by delicate concentric wrinkles. Thus a very neat reticulation is formed but is restricted to the visceral portion of the valves. On the geniculated part of the valve the sculpture consists of the coarse radiating costæ only.

In one of my specimens the internal characters are partly accessible to observation. A short bipartite cardinal process is supported laterally by two horizontal ridges extending along the hinge-line, and is continued along the inner side by a sharp median septum. This median septum can be traced for a short distance only, its continuation having been broken off in my specimen. It does not bear any groove or impression in the middle.

After numerous careful comparisons I have been unable to arrive at any satisfactory conclusions with regard to the specific relations of my Himalayan specimens. At first sight they recall some of the densely ribbed species of the group of *P. semireticulatus* with geniculate dorsal valves, such as *Productus inflatus*, McChesney, but they evidently differ from all of them in subordinate details.

Without complete specimens at hand I hardly feel justified in identifying my Himalayan species with any of the numerous species of *Productus* of carboniferous or permian age. I even suspect that it will be found distinct from all the allied forms.

*Locality and geological position: number of specimens examined.*—Grey, flaggy limestone (8*a*, Griesbach), north-west of Muth, and dark limestone (horizon *c* in Hayden's sequence): 6. (Coll. Krafft and Hayden.)

## PRODUCTUS UNDATUS, Defrance.

1842. *Productus undatus*, L. de Koninck. Description des animaux foss. du Terrain carbonifère de Belgique' p. 156, Pl. XII, fig. 2

For a complete list of synonyms I refer the reader to my memoir on the Anthracolithic fossils of Kashmir and Spiti, pt. 2 of this vol., p. 23.

The cast of a fragmentary dorsal valve is referable to this species. It strongly recalls the smaller of the two examples from Eishmakám, which have been figured in the above memoir (Pl. I, fig. 10), but is of nearly equal length and breadth.

The valve is distinctly concave, with a deeply excavated apex, with ill-defined auricular expansions, and without a median fold. Hinge-line shorter than the greatest width of the shell. The ornamentation is exactly the same as in my Himalayan specimens from the Zewán beds of Kashmir. Both the thread-like, radiating striations and the concentric lamellæ, which impart to the surface of the valve a terraced appearance, are very delicate. No traces of spines have been noticed.

*Locality and geological position: number of specimens examined.*—Fenestella shales, Losar Nullah: 1. (Coll. Krafft and Hayden.)

## PRODUCTUS SCABRICULUS, Mart., Pl. VII, figs. 15, 16, 17.

1843. *Productus scabriculus*, L. de Koninck. Desc. des animaux foss. du terr. carbon. de Belgique, p. 190, Pl. XI, fig. 3.

For a complete list of synonyms the reader is referred to my memoir on the Anthracolithic fossils of Kashmir and Spiti (pt. 2 of this vol.), p. 29.

In Hayden's and A. v. Krafft's collections from the Fenestella shales of Spiti a species of *Productus* belonging to the group of "*fimbriati*" is rather largely represented. The materials of this species of *Productus* contain a developmental series, leading from the true *Productus scabriculus*, Mart., to a form bearing much external resemblance to *P. Humboldti*, d'Orb., and its allies.

My specimens, which consist both of ventral and dorsal valves, are very variable in size and outlines, but generally broader than long, and provided with a short hinge-line, which never equals the width of the shell. All the ventral valves are provided with a distinct mesial sinus, which in some cases is of moderate depth. In the specimen illustrated in fig. 16 the strongly incurved and attenuated beak overlies the hinge-line. In this perfectly preserved example not the slightest trace of an area is visible. In the group of *P. Humboldti* a small area is usually developed, and in exceptional types may even attain to considerable dimensions, thus producing a certain resemblance to *Strophalosia*. But this tendency to develop an area has not been noticed in any of the specimens of *Productus* from the Fenestella beds of Spiti.

The ventral valve illustrated in fig. 15 may be regarded as a typical representative of the true *P. scabriculus*. Its sculpture consists of numerous moderately strong, radiating ribs, swelling out at considerable intervals into elongated protracted tubercles. This radial sculpture is crossed by a more delicate concentric ornamentation in the apical region and in the vicinity of the small, pointed wings. In its sculpture this type agrees most nearly with the Russian example of *P. scabriculus*, which has been described and figured by E. de Verneuil (Géologie de la Russie d'Europe, vol. II, Paléontologie, p. 27, Pl. XVIII, fig. 5).

A second specimen (fig. 16), which is represented by an almost complete ventral and dorsal valve, very closely approaches the Artinskian type of *P. scabriculus* as illustrated by Th. Tschernyschew (Mém. Com. géol. St. Pétersbourg, vol. III, No. 4, Taf. VI, fig. 12). Its ribs are less strongly marked and the elongated tubercles are arranged at shorter intervals. This type is connected by intermediate forms with the example illustrated in fig. 17, which bears much external resemblance to *P. Humboldti*, d'Orb. In the latter example the continuous ridges, by which the swollen-out, alternating, elongate tubercles are connected, become so delicate, that the shell no longer has the appearance of being ribbed as in the true *P. scabriculus*, but appears to be covered with numerous isolated tubercles only, exhibiting an indistinctly quincuncial arrangement. Notwithstanding this external resemblance, the figured specimen differs sufficiently in sculpture from all the species of the group of *P. Humboldti*, to render distinction easy. *P. Abichi*, Waagen, which approaches our specimen in the shape and size of the protracted tubercles, is readily distinguished by the presence of a marginal zone of closely packed pustules, whereas in my example the sculpture of the visceral and marginal regions is identical. Another point of difference is the arrangement of tubercles in a regular quincunx in *P. Abichi*. In my specimen this quincuncial arrangement is obscured by the presence of radiating ribs, which though very faintly marked are clearly indicated by their swelling out into elongated tubercles at short intervals. This arrangement of the single tubercles along radiating lines is likewise developed in the true *P. Humboldti*, d'Orbigny (Voyage dans l'Amérique Méridionale, T. III, ptie. 4, Paléontologie, Paris 1842, Pl. V, fig. 6). *P. Humboldti*, d'Orb., which is certainly distinct from *P. Humboldti*, Waagen, from the Salt Range Productus limestone, differs, however, remarkably from my Himalayan specimen in its shorter and much more closely clustered tubercles, in the ornamentation of the marginal zone of the ventral valve, and in the presence of strong, concentric ridges.

The dorsal valve is very slightly convex in the middle, with concave depressions near the margins and along the hinge-line, and with an obscurely defined mesial elevation. The apex is distinctly excavated, and on both sides of it low, diverging folds originate; these separate the flat or slightly concave wings from the visceral portions of the valve. The sculpture is more delicate than in the opposite valve. It consists of very numerous tubercle-pits and slender spines, which are arranged along indistinct radiating striæ or furrows. This radiating sculpture is intersected by a concentric ornamentation which covers the entire surface of this valve.

In the specimens illustrated in figs. 16 and 17 the internal arrangement of the dorsal valve is partly exhibited. The trifid cardinal process is supported by two horizontal ridges extending along the hinge-line, and is continued towards the interior of the valve by a strong median septum. This median septum is divided for a short distance, by a deep impression, into two separate ridges. The bipartite character of the median septum has been regarded by Davidson as a constant character of specific value in *P. scabriculus*. It is absent in the Salt Range species of the group of *P. Humboldti*, which have been described by Waagen.

The measurements of my most complete specimen (fig. 16) are as follows :—

| | | |
|---|---|---|
| Length of the shell | in a straight line | 35 mm. |
| | along the curve | 58 „ |
| Greatest breadth of the shell | | 33 „ |
| Length of the hinge-line | | 23 „ |
| Thickness of both valves | | 19 „ |
| Length of the dorsal valve | | 27 „ |

*Locality and geological position: number of specimens examined.*—Fenestella shales, Po, 4 (coll. Krafft); Losar Nullah, 11. (Coll. Hayden and Krafft.)

*Remarks.*—The identity of the Himalayan specimens with *P. scabriculus* appears to be pretty certain, at least in the case of those examples in which strong ribs are distinctly developed. In some of the more strongly weathered casts of the ventral valves the ribbing so far predominates over the partly destroyed tubercles, that without a careful examination they may be mistaken for casts of *P. semireticulatus*. From such types with coarse ribs, from which the protracted tubercles originate, to those forms in which the ribbing is by far inferior to the tubercular element of ornamentation, many intermediate forms have been observed.

If a varietal designation should be considered appropriate for such forms, the prototype of which has been illustrated in fig. 17, the name ***Productus scabriculus*** var. ***spitiensis*** might be proposed.

### PRODUCTUS NYSTIANUS var. LOPINGENSIS, Kayser, Pl. VII, figs. 18, 19, 20.

1883. ***Productus Nystianus*** var. ***lopingensis***, Kayser. Obercarbonische Fauna von Loping, Richthofen's "China" IV, p. 187, Taf. XXVIII, figs. 1—5.

This is the commonest species among the Brachiopoda of the Fenestella beds of Spiti. It is very numerously represented among the materials collected by Hayden and A. v. Krafft in the vicinity of Po, but most of the specimens are either fragmentary or deformed by crushing. Nevertheless the examination of several better preserved specimens has convinced me of their identity with the Chinese variety of ***Productus Nystianus***, de Kon. The most satisfactorily preserved examples agree very closely with the figures and description of this shell given by Kayser.

Only ventral valves have been available for examination. The few fragments of dorsal valves which occur among my materials are too indifferently preserved to allow any of their characters to be established with certainty.

All my specimens are small, none of them exceeding 15 mm. in length and 20 mm. in width. They are of semicircular or quadrato-rotundate outlines, and always more or less transversely elongate. The specimen illustrated in fig. 19, represents the normal, that illustrated in fig. 18, an exceptionally transverse, form. The straight hinge-line either corresponds to the greatest width of the shell, or is only slightly shorter. Its cardinal edges are sharply rounded.

In most of the crushed specimens only the flattened or moderately convex visceral portion of the ventral valve is accessible to observation. It is provided with a very small slightly incurved apex, which projects barely beyond the hinge-line. The auriculate expansions are distinctly developed, flat, and often separated from the remainder of the shell by a kind of groove or furrow. The surface is covered with numerous concentric wrinkles of very irregular strength and arrangement. The wrinkles are often undulating and interrupted at irregular intervals by stout, coarse tubercles or by deep impressions. The wings are generally free from tubercles, being ornamented only with delicate concentric striæ. Notwithstanding the great variability in the sculpture, its pattern is constant in all my specimens, and constitutes a very characteristic feature of this interesting species.

On three specimens I have succeeded in chiselling out the marginal portion of the ventral valve. These specimens clearly exhibit the remarkable geniculate character of the ventral valve in *P. Nystianus*. The shell is abruptly bent at a right angle towards the margins. Thus a steep trail is formed, which surrounds the visceral region of the valve and unites with the latter in a sharp, slightly elevated edge. This anterior or bent portion of the valve is broadest near the front, but gradually diminishes in width towards the cardinal edges. It is nearly smooth, interrupted only by a very few longitudinal ribs, and by numerous but very delicate pustules.

My specimens agree with the Chinese variety of *P. Nystianus* in those characters which distinguish it from the European types of L. de Koninck's species, from the mountain limestone of England and Belgium. Such characters are the presence of a sharp edge, in which the marginal and visceral portions of the ventral valve unite, and of numerous spines, which are not restricted to the cardinal region. The illustration in fig. 20 shows a specimen imbedded in the matrix and surrounded by long spines all around its margins.

The measurements of a typical specimen (fig. 19) are as follows:—

| | |
|---|---|
| Entire length } of the shell | 15 mm. |
| Entire breadth } of the shell | 19 ,, |
| Thickness of the ventral valve . . . . . | 5·5 ,, |
| Breadth of the marginal trail . . . . . | 3 ,, |

*Locality and geological position: number of specimens examined.*—Fenestella shales, Po: 26. (Coll. Hayden and Krafft.)

### DERBYIA cf. SENILIS, Phill., Pl. VII, fig. 13.

For a list of synonyms the reader is referred to my memoir on the Anthracolithic fossils of Kashmir and Spiti (pt. 2 of this volume), p. 52.

A small number of specimens from Hayden's and Krafft's collections, consisting of ventral and dorsal valves attached to each other, are very closely allied to this well-known British species of carboniferous age. The appurtenance of the Himalayan examples to Waagen's genus *Derbyia* is pretty certain, the characteristic median septum of the ventral valve being visible through the transparent shell in one of my specimens. All my examples are of small size, nearly semicircular, and with only slightly inflated valves. The hinge-line is shorter than the greatest width of the shell and terminates in obtusely rounded cardinal angles.

The ventral valve is slightly but regularly convex throughout, without any mesial furrow or sinus. The dorsal valve is moderately convex. Both valves are covered with numerous strong, radiating costæ, which increase in number towards the margins either by dichotomy or by intercalation of new ribs. In their ornamentation my specimens do not agree perfectly with any of the British types figured by Professor Davidson, nor with any of Waagen's so-called species of the group of *Derbyia senilis* from the Salt Range Productus limestone. Their costæ are coarser, less numerous, more regular and not wrinkled. They are only very rarely intersected by regular concentric ridges of growth.

Every palæontologist, who knows the extreme difficulty of distinguishing the several species within the genus *Derbyia*, will appreciate my reasons for making no attempt to identify my Himalayan examples with any of them. Their ornamentation, indeed, does not agree sufficiently well with that of *D. senilis* to allow of certain identification. On the other hand, the differences are too small to be of specific importance. I consequently prefer to place these shells for the present provisionally under *Derbyia* cf. *senilis*.

The measurements of the figured specimen are as follows:—

| | | |
|---|---|---|
| Entire length } of the shell | ca. { 18 | mm. |
| ,, breadth } of the shell | 21 | ,, |
| Length of the dorsal valve | 16·5 | ,, |
| Thickness of both valves | 8 | ,, |
| Length of the hinge-line | 17 | ,, |

*Locality and geological position: number of specimens examined.*—Flaggy limestone (8*a*, Griesbach), north-north-west of Muth: 3. (Coll. Hayden and Krafft.)

*Remarks.*—Besides these three specimens, which might be referred to *Derbyia senilis* with great probability, there is a very large number of single ventral and dorsal valves of *Derbyia* among Hayden's and Krafft's collections from the flaggy limestone of Muth and from the overlying horizon of shales and limestones. Some of the strongly inflated dorsal valves might be compared with *D. crassa*, Meek. The difference in the ornamentation of my Himalayan examples clearly shows that more than one species must be represented in the fauna of the limestone 8*a*, but it seems to me quite impossible to arrive at any satisfactory conclusion regarding their specific relations.

### SPIRIGERA (ATHYRIS) cf. BOYSSII, Lév., Pl. VII, fig. 14.

It is with all reserve that I attribute a small example of a *Spirigera* to this species, but this identification will hardly be considered correct by those palæontologists who are inclined to follow L. de Koninck's views regarding the advisability of a very narrow circumscription of species in the genus *Spirigera*.

My specimen is of small dimensions and of a nearly circular outline, with equally inflated valves. In the ventral valve an indistinct sinus is faintly indicated. Consequently the corresponding curve in the front line is very shallow. The beak is thick, only slightly prominent, and truncated by a moderately large foramen.

The surface of the shell is covered by numerous concentric lamellæ of growth. The shell has been perfectly preserved in some parts of the dorsal valve. Thus I have been enabled to ascertain the entire absence of the peculiar ornamentation which is a leading feature in the permian *Spirigera pectinifera*, Sow. With this species, the smaller forms of the Productus limestone—those without a distinct sinus—have been identified by Waagen. The Salt Range specimens quoted by Waagen under the latter denomination differ, however, from the present example by their remarkable sculpture.

Notwithstanding the similarity of the Himalayan specimen with shells which have been referred to one or other of the synonyms of *Sp. Boyssii* by several palæontologists, it must be borne in mind that determinations of young individuals, like the present one, always remain somewhat doubtful, since some species of *Spirigera* do not develop their distinctive features before having reached their full-grown stage.

The measurements of the figured specimen are as follows :—

| | |
|---|---|
| Entire length } of the shell | 12 mm. |
| " breadth } of the shell | 12 " |
| Length of the dorsal valve | 11 " |
| Thickness of both valves | 7 " |

*Locality and geological position: number of specimens examined.*—Flaggy limestone (8*a*, Griesbach), north-west of Muth : 1. (Coll. Krafft.)

### SPIRIFER cf. STRANGWAYSI, Verneuil, Pl. VII, fig. 8.

1845. *Spirifer Strangwaysi*, E. de Verneuil. Géologie de la Russie d' Europe, vol II, pt. 3. Paléontologie, p. 164, Pl. VI, fig. 1.
1878. *Spirifer Strangwaysi*, Trautschold. Die Kalkbrueche von Miatschkowa, II, Th. p 78, Taf. VIII, fig. 4.
1890. *Spirifer Strangwaysi*, Nikitin. Mém. Com. Géol. St. Pétersbourg, vol. V, No. 5, p. 66.
1898. *Spirifer Strangwaysi*, L. v. Lóczy. Wissenschaftliche Ergebnisse der Reise des Grafen Béla Széchenyi in Ostasien, III, Bd. 4, Abth. p. 90, Taf. III, figs. 5—7.

In Krafft's and Hayden's collection this species is represented only by fragments of ventral valves.

The most complete example, which has been chosen for illustration, is of markedly transverse shape, being more than twice as broad as long. The hinge-line corresponds to the greatest width of the shell. The valve is only gently arched, and is provided with a moderately broad and deep sinus. It originates exactly at the apex as a narrow and deep impression, but increases in width rather rapidly towards the front. There are four distinct ribs within the sinus. The lateral borders of the sinus are sharply marked.

The sculpture of the lateral parts consists of single, regular ribs, which are rounded above and occur, to the number of twelve to fifteen, on either side of the sinus. The ribs and the intercostal depressions are of equal width. The area, though very imperfectly preserved, seems to have been very low.

I should certainly not have ventured on a doubtful identification of this specimen with *Spirifer Strangwaysi* without the figures and descriptions of that species given by Trautschold and L. v. Lóczy. In such of its characters as are accessible to observation my ventral valve so strongly recalls the Chinese shells, illustrated by L. v. Lóczy, that I am not prepared to offer any suggestion as to their identity other than the above. The only difference consists in the more highly vaulted, longitudinal profile of the majority of Lóczy's examples. In this respect my specimen agrees more closely with the Russian shell illustrated by Trautschold.

Another species which bears a marked affinity to the present one is *Sp. carnicus*, Schellwien (Die Fauna des Karnischen Fusulinen Kalkes I. Th., Palæontographica, 39 Bd., p. 45, Taf. IV, figs. 1—5). I have been able to ascertain this affinity by comparing my Himalayan specimens with some of Schellwien's type-specimens from the upper carboniferous Fusulina limestone of the Garnitzenhöhe in Carinthia. The only differences I can observe between them are the arrangement of ribs within the sinus—which is, however, not regular in all the Alpine examples,—and the slightly less coarse character of the lateral ribs in my Himalayan type-specimen. In the pattern of its sculpture the latter chiefly agrees with *Sp. carnicus* in the development of straight, only slightly diverging ribs and the total absence of wavy costæ, such as are seen in *Sp. convolutus*, Phill. Its ornamentation is much more delicate than in *Sp. trigonalis*, Mart.

*Locality and geological position: number of specimens examined.*—Flaggy limestone (8*a*, Griesbach) : 4. (Coll. Hayden and Krafft.)

### SPIRIFER CURZONI, nov. sp., Pl. VII, figs. 2—6.

1899. *Syringothyris cuspidata*, Diener, (*non* Martin). Anthracolithic fossils of Kashmir and Spiti, Palæont. Ind, ser. XV, Himalayan Foss., vol. I, pt. 2, p. 76, Pl. IV, figs. 9, 10.

1900. *Syringothyris* cf. *cuspidata* et *S.* cf. *distans*, Hayden. General Report, Geol. Surv. of India, 1899-1900, p 48.

When describing the Brachiopoda which had been collected in the Kuling series of Spiti by Stoliczka, I erroneously believed that two specimens—a ventral and a dorsal valve—which, however, did not belong to the same individual, were referable to the common mountain limestone species *Syringothyris cuspidata*, Mart. But a subsequent examination of a series of specimens, collected by Hayden and Krafft, has led me to infer that I was not correct in placing them among the genus (or sub-genus) *Syringothyris*, Winchell. In 1899 the scarcity of my materials available for examination precluded any attempt to make out the internal characters of the ventral valve. My uncertainty as to the internal arrangement of the present species has been recently removed by Krafft's and Hayden's fortunate discovery of a large number of specimens, three of which have been sacrificed for the study of their internal characters.

The following results have been obtained:—

From the inner walls of the deltidial fissure two dental plates or septa originate, and strongly diverge towards the posterior margin of the ventral valve. They are confined to the apical region, and are extremely thickened in the vicinity of the beak, where they form one compact shelly mass together with the outer walls of the shell. As they approach the inner part of the apical region they gradually diminish in strength (figs. 5 $a-b$). In one of my examples (fig. 5) they nearly touch the bottom of the valve, whereas in a second one they only reach for a short distance towards the posterior margin of the valve (fig. 6). A transverse plate or a tubular process has not been observed in any of my three specimens. That the absence of such characters of generic or sub-generic importance in three specimens is only accidental, cannot be supposed, especially if the excellent preservation of the dental lamellæ is taken into consideration. Thus we must necessarily come to the conclusion that the present species is no *Syringothyris*, the distinctive features of which are entirely missing, but a true *Spirifer* of the gronp of *aperturati*.

This conclusion is corroborated by the fact that the structure of the shell is distinctly fibrous, not punctate. It has been demonstrated by Meek (Proceed. Acad. of Nat. Sciences, Philadelphia, vol. IX, 2 ser. 1865, p. 275) that all species of *Syringothyris* with a transverse plate and split tube are provided with very delicate pores, which impart a "patchy" punctation to their shell substance. Although this punctation is easily destroyed on account of the very small size of the single pores, its absence in so large a series of specimens as have been available to me for examination cannot be explained by their accidental state of preservation only, in several examples the surface of the shell, which had been cleared from the matrix, being perfectly fresh and not injured by weathering.

Thus Hayden and I have probably been in error in identifying the present species with the European *Syringothyris cuspidata*, Mart., as it is neither characterized by a punctate shell-structure, nor by the presence of a transverse plate and tubiform process in its ventral valve. It must consequently be classed among the genus *Spirifer*, and receive a new denomination, for which the name of *Curzoni* is proposed.

Although the external features of the species have been described in the second part of the present volume, much new information has been added by the examination of the large series of specimens collected by Hayden and A. v. Krafft.

Ventral and dorsal valves are always found separated. I have not met with a single complete specimen in which the two valves were attached to each other. Both valves are extremely variable in shape and dimensions. Specimens of so large size as those which have been illustrated in my above-quoted memoir are quite an exception. The ventral valve is very variable in its curve and in the width of its area. Examples with the shapes of a true *Cyrtina* or *Syringothyris* are found mixed together with specimens in which the area is barely higher than in many species of *Spirifer* belonging to the group of *aperturati*. The acute apex is not always erect as in the specimen collected by Stoliczka, which has been erroneously identified with *S. cuspidata*, but slightly incurved, as in *Sp. audaculus*, Conr. In the majority of specimens the area is more or less distinctly concave, but in exceptional shapes it is perfectly flat and perpendicularly elevated above the straight hinge-line. The triangular fissure is of very variable width and height. In some individuals its height is more than twice as great as its breadth, whereas in others it is but little greater. The sinus is always regularly rounded at the bottom, and devoid of any radiating sculpture. Its lateral borders are sharply rounded. The lateral parts are ornamented with a variable number of single, straight, radiating ribs with rounded tops, and becoming gradually obsolete in the vicinity of the wings.

The smaller valve, which has been illustrated on Pl. IV, fig. 10, of the second part of the present volume, does not represent the typical form of the species. It is much more strongly convex than the majority of specimens, which are but little curved in either direction. On the other hand, the mesial fold is, as a rule, more considerably elevated above the general convexity of the valve. Specimens with subelliptical outlines are rare. In the majority of my examples the lateral margins form a convex curve to within a short distance from the cardinal angles, where they are prolonged with acute terminations. By this feature they are externally distinguishable from *S. cuspidata*.

An external feature of distinction, which is yet more conspicuous, is the presence of concentric laminæ intersecting the radial sculpture. The specimen represented by the dorsal valve from Stoliczka's collection was an internal cast, on which no traces of a concentric ornamentation were indicated. In my present materials the development of lamellose concentric striæ is also very variously developed. It is well exhibited in the small specimen, illustrated on Pl. VII, fig. 3, where as it is barely at all observable in the example illustrated in fig. 4. In the majority of my specimens this concentric ornamentation had been greatly injured or destroyed by weathering.

*Locality and geological position : number of specimens examined.*—Flaggy limestone (8*a*, Griesbach) and shales and limestones of the following horizon (*c*, Hayden), north-west of Muth : 42. (Coll. Hayden and Krafft.)

*Remarks.*—*Spirifer Curzoni* belongs to a group of the "*aperturati*" which exhibits a rather ancient aspect. We are more accustomed to meet with similar forms in beds of devonian than of carboniferous age. *Sp. Marcyi*, Hall, *Sp. ligus*, Owen, *Sp. audaculus*, Conr., from the Hamilton group, and *Sp. arctisegmentus*, Hall, from the Helderberg group of the devonian system, are typical representatives of this section of *Spiriferidæ*, which are most numerously developed in devonian strata but become already scarce in beds of lower carboniferous age. A Himalayan species of upper carboniferous age which appears to me closely allied to the present one is *Sp. Lydekkeri*, Diener (part 2 of this vol., p. 72, Pl. III, figs. 1—4), from the Zewán beds of Kashmir.

Although there is no doubt as to their being specifically distinct, they agree in the majority of their essential features, especially so in their outlines and sculpture. The lamellose character of the concentric ornamentation is, however, much more clearly developed in *Sp. Lydekkeri*, thus recalling particularly the Australian *Sp. Clarkei*, de Koninck (Recherches sur les foss. paléozoiques de la Nouvelle Galles du Sud, p. 236, Pl. XIII, fig. 2).

An upper carboniferous species which bears the most intimate relationship to the present one will be described by Tschernyschew as *Sp. tastubensis*, nov. sp. The illustrations of this Russian species from the Schwagerina limestone of the Ural Mounts on Pl. IX, figs. 1—3, of Tschernyschew's monograph show no other difference from my Himalayan examples than a little more strongly transverse outline and a less deeply impressed sinus. Otherwise they agree so perfectly, even in the presence of a delicate, concentric ornamentation, that the question may be raised whether *Sp. Curzoni* ought not rather to be considered merely as a variety of *Sp. tastubensis* than as an independent species. This question can, however, be decided only with Tschernyschew's type-specimens of his Russian species at hand for comparison.

A species of permocarboniferous age to which the present one might also be compared is, perhaps, *Sp. Bistritzæ*, Schellwien (Abhandl. K. K. Geol. Reichs-Anst. XVI, Taf. XII, figs. 3—7), from the Trogkofelschichten of Carniola. This Alpine species is probably a true *Spirifer* notwithstanding its external similarity to *Syringothyris*, none of the internal characters of the latter genus having been discovered by Schellwien in his Carnian examples.

In my memoir on the anthracolithic fossils of Kashmir and Spiti I have been led to suppose that Stoliczka's specimens had been collected from a lower carboniferous limestone, which in the Niti area occurs below the white quartzite of upper carboniferous age. In this supposition, however, I have been mistaken. From Hayden's recent survey of Spiti we know that the lowest bed exposed in the section of Kuling is the white quartzite, and I am quite disposed to concur with Mr. Hayden that Stoliczka's specimens have been collected in the limestone (8*a*, Griesbach), and that the inference of the lower carboniferous age is therefore not justified.

### SPIRIFER sp. ind. ex aff. S. CURZONI, Diener, Pl. VII, fig. 7.

This species is probably very closely allied to *Spirifer Curzoni*, but my materials are too scanty to allow anything to be asserted more positively, the species being represented only by a single, though fairly well-preserved, dorsal valve.

In its outlines it agrees exactly with *Sp. Curzoni*, but in its sculpture it is distinguished by some peculiarities which forbid a specific identification. The lateral ribs are smaller in number, more robust and prominent, and the elevated mesial fold is not smooth, but ornamented by a few ribs of equal strength.

I know of no other species which could be more particularly compared with the present one than the devonian *Spirifer disjunctus* var. *sulcifer*, Hall (Introduction to the study of the genera of palæozoic Brachiopoda, Palæontology of New York, vol. VIII, Pt. 2, Pl. XXX, fig. 16), and its allies. In the present specimen a sulcus is likewise noticed corresponding to the median line of the plicated dorsal fold.

*Locality and geological position: number of specimens examined.*—Flaggy limestone (8*a*, Griesbach), north-west of Muth: 1. (Coll. Hayden and Krafft.)

SPIRIFER (AMBOCŒLIA ?) sp. ind. aff. FUSIFORMI, Phill., Pl. VII, fig. 12.

Among the fossil materials collected by Hayden and A. v. Krafft there is a single, but nearly complete, specimen of a smooth *Spirifer* of transverse outline, with unequal convex valves.

The specimen is nearly twice as broad as long. The hinge-line is shorter than the greatest width of the shell. Its cardinal angles are slightly rounded.

The ventral valve is strongly inflated and provided with a thick, but little prominent beak. As it has been partly injured by weathering, the details of its outlines cannot be made out with full certainty. The beak bears on its dorsal side an extremely small triangular area, which is reduced to two narrow, flattened strips along the hinge-line. It is not separated distinctly from the remainder of the valve, but gradually passes into the lateral portions of the apical region with regularly rounded ridges. A very shallow and narrow sinus extends from the extremity of the beak to the front-margin.

The dorsal valve is considerably less deep than the opposite one. An indistinctly defined mesial fold is restricted to the vicinity of the apical region.

The surface is perfectly smooth. My specimen being a cast, devoid of shell substance, nothing can be stated regarding the structure of the latter.

The measurements of the present specimen are as follows:—

| | |
|---|---|
| Entire length of the shell . . . . . . | 10 mm. |
| „ breadth „ „ „ . . . . . . | 17 „ |
| Length of the dorsal valve . . . . . . | 9 „ |
| Thickness of both valves . . . . . . | 7 „ |

*Locality and geological position: number of specimens examined.*—Flaggy limestone (8*a*, Griesbach), three feet above base, north-west of Muth: 1. (Coll. Krafft.)

*Remarks.*—The only species to which the present one might be compared is *Spirifer fusiformis*, Phill. Phillips' type-specimen, as figured by Davidson (Monogr. British Carbon. Brachiopoda, Pl. XII, fig. 15) agrees with my Himalayan example in the transverse shape, the smooth surface and the unequal convexity of the valves. It differs, however, in the following characters: the British species is more strongly fusiform, the median fold of its dorsal valve is more distinctly marked, its hinge-line corresponds to the greatest width of the shell and terminates in acute cardinal angles. Thus an identification of the two species is impossible.

The reference of *Sp. fusiformis* and of the present species to the genus or sub-genus *Ambocœlia*, Hall (XIII, Report, New York State Cab. Nat. Hist., p. 71), is questionable, as we are without conclusive evidence of the nature of the interior in both fossils. The external similarity with *Amb. Telleri*, Schellwien (Die Fauna der Trogkofelschichten in den Karnischen Alpen und den Karawanken, Abhandl. K. K. Geol. Reichs-Anst. XVI, p. 90, Taf. XIV, figs. 1—3), however, speaks strongly in favour of their appurtenance to *Ambocœlia.*

### Martiniopsis cf. subpentagonalis, Waagen, Pl. VII, fig. 11.

1882. ***Martiniopsis subpentagonalis***, Waagen. Salt Range Foss. Palæont. Indica, ser. XIII, vol. I, Productus Limestone Foss., p. 527, Pl. XLII, figs. 9, 10, Pl. XLIII, fig. 1.

1900. ***Martiniopsis subpentagonalis***, Enderle. Ueber eine anthracolithische Fauna von Balia Maaden in Kleinasien, Beiträge zur Geol. u. Palæont. Oesterr.-Ungarns, etc., XIII, p. 84, Taf. VII, fig. 10.

Among the materials collected in the flaggy limestone south-east of Muth by A. v. Krafft there is a fragmentary ventral valve of a smooth *Spirifer* which exhibits the internal arrangement peculiar to Waagen's genus (or sub-genus) *Martiniopsis.* Two strongly developed dental plates distinctly show through the transparent shell from the apex to one-third of the length of the ventral valve. This character, which is combined with a clearly marked, though very delicate punctation, of the shell, allows the present specimen to be assigned to *Martiniopsis.*

In its general shape my specimen agrees with *Martiniopsis subpentagonalis,* Waag., from the lowest division of the Productus limestone (Amb beds). The ventral valve, which alone is available for examination, is moderately and very regularly curved. Although this valve is somewhat flattened along its middle portion, a sinus is entirely absent. The beak is high, prominent and moderately incurved. The area is marked off indistinctly from the remainder of the shell by low and rounded ridges. It is interrupted in the middle by a high and comparatively narrow triangular fissure. I am not able to state whether a pseudodeltidium was present or not.

My specimen is too incomplete to allow a definite identification. It is with all reserve that I venture to quote it under a specific denomination. It will at any rate tend to show the existence of the sub-genus *Martiniopsis* in the anthracolithic rocks of Spiti.

### Rhynchonella confinensis, Schellwien, Pl. VII, fig. 9.

1862. ***Rhynchonella angulata*** (?) Val. v. Mœller. Geol. and palæontol. researches in the Ural Mts. (in Russian), Gornoj Journal, vol. IV, Pl. VII, fig. 2.

1892. ***Rhynchonella confinensis***, Schellwien. Die Fauna des Karnischer Fusulinen Kalkes, I Th., Palæontographica, XXXIX, p. 54, Taf. VIII, figs 11, 12.

1900. ***Rhynchonella confinensis***, Schellwien. Die Fauna der Trogkofelschichten in den Karnischen Alpen und den Karawanken, Abhandl. K. K. Geol. Reichs-Anst. XVI, Heft. I, p. 93, Taf. XIV, figs. 8—10.

This is perhaps the most remarkable species of *Rhynchonella*, and is easily distinguished from all congeneric forms by its laterally compressed shape. A ventral valve of this species in a state of good preservation has been found among the fossil materials collected by Dr. v. Krafft in the limestone north-west of Muth, 200 feet above its base.

My specimen distinctly exhibits the laterally compressed and emarginated outlines peculiar to the Alpine shells. In the longitudinal direction it is more strongly and regularly curved than the ventral valve which has been figured by Schellwien. The beak is moderately produced, strongly compressed and incurved. In the visceral region a deep and narrow sinus originates, which extends to the front. It is rounded at the bottom and perfectly smooth, not provided with secondary ribs as in *Rhynchonella angulata*, L. From the two rounded ribs which border the mesial sinus the lateral parts of the valve slope abruptly on either side. Three broad ribs occupy each side of the lateral portions, which are deeply serrated along their margins. The front margin has not been preserved in my specimen, but there is reason to suppose that the extremity of the sinus was tongue-shaped and strongly geniculated.

Although this species has only been met with in a single ventral valve, its characters are seen at once clear and distinct, the laterally compressed shape and the peculiar sort of ribbing rendering it a very conspicuous fossil. From *Rhynchonella angulata* of lower carboniferous age it is easily distinguished by its smooth sinus and rounded ribs.

*Locality and geological position: number of specimens examined.*—Flaggy limestone (8*a*, Griesbach), north-west of Muth: 1. (Coll. Krafft.)

### RHYNCHONELLA cf. WYNNEI, Waagen, Pl. VII, fig. 10.

1883. *Rhynchonella Wynnei*, Waagen. Salt Range Fossils, Palæontologia Indica, ser. XIII, vol. I, Productus Limest. Foss., p. 432, Pl. XXXIV, fig. 4.

1900. *Rhynchonella Wynnei*, Schellwien. Die Fauna der Trogkofelschichten in den Karnische Alpen und den Karawanken, Abhandl. K. K. Geol. Reichs-Anst. XVI, p. 94, Taf. XIV, figs. 11—13.

The genus *Rhynchonella* is rather numerously represented among the fossil materials which have been collected by A. v. Krafft in the limestone (8*a*, Griesbach) of Muth. Most of the specimens, however, are fragmentary. There is only one specimen which appears to be sufficiently well preserved to allow a specific identification. It is most nearly allied to some of the Alpine examples which have been united with *Rhynchonella Wynnei*, Waag., by Schellwien, but differ remarkably from Waagen's type-specimen of the Salt Range species by their less globular shape.

Waagen's type-specimen from Kálabágh is provided with extremely inflated valves of nearly equal length, width and thickness, recalling in their globular outlines *Rhynchopora geinitziana*, Vern. My specimen is almost twice as long and broad as it is thick, but, apart from this difference in the inflation of the valves, agrees closely with the Salt Range species in its other characters, especially in the arrangement of the mesial fold and sinus, and in its sculpture. The differences existing between my Himalayan specimen and the common *Rhynchonella pleurodon*, Phill., are the same which induced Waagen to propose a proper specific denomination for his shell from the Salt Range Productus limestone. The lateral parts of the ventral valve are less strongly developed, the median fold of the dorsal valve is less prominent and provided with a smaller number of angular ribs, and the sinus is less deeply impressed. There are, however, only four ribs in the median fold of the dorsal valve, and seven in each of the comparatively narrow lateral parts. The ribs within the sinus and the dorsal fold are more strongly developed than those on the lateral parts of both valves. The ribs are angular and originate near the apex. By this character and by the greater number of ribs, my Himalayan specimen is at once distinguished from *Rh. sosiensis*, Gemm., and its allies.

The shell substance has been partly preserved. It is fibrous and not punctate. Thus the specimen cannot belong to the genus *Rhynchopora*, notwithstanding its external similarity with *Rhynchopora Nikitini*, Tschern., and *Rh. variabilis*, Stuckenberg.

The measurements of my specimen are as follows:—

| | |
|---|---|
| Entire length } of the shell | 14 mm. |
| " breadth } of the shell | 14 " |
| Length of the dorsal valve | 12·5 " |
| Thickness of both valves | 8 " |

*Locality and geological position: number of specimens examined.*—Dark, flaggy limestone (8*a*, Griesbach), north-west of Muth: 1. (Coll. Krafft.)

*Remarks.*—A direct identification with *Rhynchonella Wynnei*, Waagen, is not advisable, in view of the comparatively flat shape of my Himalayan specimen. On the other hand it must not be overlooked that Waagen's diagnosis of his Salt Range species was based on a single specimen only. The larger number of examples which have been collected in the permocarboniferous rocks of Carniola by Schellwien, convey a clearer idea of the variability of the species. Among the specimens illustrated in Schellwien's memoir there is one (fig. 13) which in its shape more nearly approaches my Himalayan example than Waagen's type-specimen. If the globular shape were not to be considered a character of specific importance in *Rh. Wynnei*, the present specimen might be safely identified with Waagen's Salt Range species.

### CAMAROPHORIA nov. sp. ind. (aff. ACUMINATA, Gemm. ?), Pl. VII, fig. 21.

A single, partly injured, but almost complete, example of a small *Camarophoria* has been met with in the Fenestella beds of the Losar Valley. It certainly belongs to a new species, but, not wishing to burden nomenclature with a new name based on such insufficient materials, I prefer to quote it as *sp. ind.* with reference to *Camarophoria acuminata*, Gemmellaro (La fauna dei calcari con Fusulina della Valle del F. Sosio, Fasc. IV, pt. 1, p. 265, Tav. XXVII, figs. 8—13), which is probably among its nearest allies.

My specimen is of pentagonal shape, equal length and breadth, and perfectly symmetrical. It agrees with *C. acuminata* in the strongly attenuated character of the apical region, in the very little prominent mesial lobe of the dorsal valve, and in the absence of a false area. It differs, however, from this species and from the nearly allied *C. Humbletonensis*, Howse, by the small inflation of its valves, by its shallow frontal wave, by the development of a low depression along the median line of the dorsal valve—recalling some triassic species of *Retzia*—and by its ornamentation.

Three ribs occupy the surface of the median sinus and five that of the corresponding median fold. Six to seven ribs are counted on each of the lateral parts.

All the ribs originate in the small and pointed beak. Thus no portion of the surface of the shell is left smooth as in *C. acuminata*, or in the congeneric species from the Belgian and British mountain limestone, in which the ribs generally commence at about the middle of the shell.

Of the internal arrangement the two dental plates in the ventral valve and the septum, which supports the spatula-shaped process in the dorsal valve, can be distinctly seen in my specimen.

The measurements of my specimen are as follows :—

| | |
|---|---|
| Entire length } of the shell | 12·5 mm. |
| „ breadth } of the shell | 12·5 „ |
| Length of the dorsal valve | 12 „ |
| Thickness of both valves | 7 „ |

*Locality and geological position : number of specimens examined.*—Fenestella shales, Losar Nullah : 1. (Coll. Hayden and Krafft.)

*Remarks.*—This is the only species of *Camarophoria* known to me in which a flat shape is united with an ornamentation covering the entire surface of the shell. Among the congeneric species from the upper carboniferous rocks of the Eastern Alps and of Russia there is none which could lay claim to closer comparison.

### CAMAROPHORIA sp. ind.

Among my fossil materials from the Fenestella shales of Po there are numerous casts of a moderately large *Camarophoria* which in its general characters recalls *C. Purdoni*, Dav., or *C. alpina*, Schellw., but is distinguished from both species by the presence of more numerous ribs, which cover the entire surface of the shell. All my examples are so strongly crushed and deformed that they are absolutely unfit for specific determination.

I should not have mentioned these poorly preserved casts were it not for the fact that casts perfectly identical in shape have been noticed by myself in sericitic slates and quartz sandstonesf rom the Ladakh Valley, which had been collected by Lydekker.

In my memoir on the anthracolithic fossils of Kashmir and Spiti I have alluded to the presence of badly preserved *Rhynchonellidæ* in the sericitic shales of the Ladakh Valley, which I believed to be probably equivalents of the Zewán or Barus beds of upper-carboniferous age. In one of my casts from the Fenestella shales of Po the strong dental plates of *Camarophoria* are visible. A subsequent examination of similar casts in a slab of rock from the Ladakh Valley leads me to suppose that the species from the Fenestella beds of Po and from the sericitic slates of the Ladakh Valley are probably identical.

## BRYOZOA.

There is no more difficult group among the fossils from the anthracolithic series of Spiti than the *Bryozoa*. Their exact determination is rendered almost impossible by their imperfect state of preservation. In the Fenestella beds of Po and of the Losar Nullah remains of Bryozoa abound, but they are usually found in the condition of strongly weathered casts only, or of impressions left by the removal and decay of the polyzoarium. With the single exception of *Protoretepora ampla*, Lonsd., I have not succeeded in finding out one single specimen, from which information concerning the nature of the cells on the poriferous side could be gathered. Very little reliance, however, can be placed on the general appearance of my examples of *Fenestella*, the external features of the species apparently running into one another in a most perplexing manner.

To this another fact is added which renders the specific determination of *Fenestellæ* exceedingly difficult. This is the very narrow interpretation of species which has been introduced by Struckenberg in his monograph on the Anthozoa and Bryozoa of the carboniferous rocks of the Ural and Timan (Mém. Com. géol. St. Pétersbourg, 1895, vol. X, No. 3). This interpretation of species, which has been based on very rich and well-preserved materials, peremptorily forbids any attempt of a specific determination, if one has to do with imperfect examples only.

In the absence of reliable characters for an exact determination of my materials of *Fenestellæ* I deemed it preferable to content myself with signalizing the presence of such forms among them as are most probably identical with species from the Zewán or Barus beds of Kashmir.

### FENESTELLA sp. ind. aff. PLEBEIA, M'Coy.

1889. *Fenestella* sp. ind. aff *fossula*, Diener. Anthracolithic Fossils of Kashmir and Spiti, Palæontologia Indica, ser. XV, Himalayan Foss, vol. I, pt. 2, p. 83, Pl. VII, fig 8; Pl. VIII, fig. 4.
1899. *Fenestella* sp. ind. aff. *internata*, Diener. *Ibidem*, p. 84, Pl. VII, fig. 9; Pl. VIII, fig. 3.

These two forms of *Fenestella* which have been quoted by myself from the Zewán beds of Kashmir are very numerously represented among my materials from the Fenestella shales of Po in Spiti. They are externally characterized by a densely retiform appearance, by rarely dichotomising branches, and by the regular arrangement of the delicate, slender dissepiments and interstices, enclosing rectangular fenestrules, bordered by nearly straight bars.

Among my materials from Kashmir the distinction of two forms seemed possible to me, the second differing from the first-quoted in being of a larger habit. I can no longer maintain this view in the face of my materials from the Fenestella shales of Po, having before me specimens in which the characters of the two forms actually run into one another. The number of meshes or fenestrules which may be counted within the space of 5 mm. is so variable in different parts of the same polyzoarium that no specific distinction can be based on this feature. This number of meshes varies from 3 to 10 in the direction of the extension of the branches, and from 5 to 14 in the transverse direction.

The appurtenance of the present species to the genus *Fenestella* is pretty certain, traces of a median keel having been occasionally noticed in the hollow spaces left in casts of the poriferous side by the impression of the branches.

In my memoir on the anthracolithic fossils of Kashmir and Spiti I have compared this species to two Australian ones—*F. fossula*, Lonsd., and *F. internata*, Lonsd., as their nearest allies. My knowledge of the species is, however, too incomplete to decide whether some European and American species of carboniferous age, especially *F. plebeia*, M'Coy, and *F. perelegans*, Meek, might not be more nearly allied. It is especially the common mountain limestone species *Fenestella plebeia*, M'Coy (Synopsis of the characters of the carboniferous fossils of Ireland, 1844, p. 203, pl. XXIX, fig. 3), which in its external characters—fan-shaped, flat colony, rectangular fenestrules, which are twice or three times longer than broad, thin and regular dissepiments, longitudinally striated non-poriferous side of the branches—very closely resembles some of my Himalayan specimens. A constant difference exists, however, in the more slender shape of the interstices of the Himalayan species, being only one-half to one-third as broad as the fenestrules, whereas interstices and fenestrules are of equal width in *F. plebeia*. A similar remark also applies to the differences between the present species and *F. perelegans*, Meek (Palæontology of Eastern Nebraska, Final Report upon the U. S. geol. surv. of Nebraska, by Meek and Hayden, p. 153, Pl. VII, fig. 3).

Waagen united *Fenestella fossula*, Lonsd., *F. veneris*, Fisch., and *F. jabiensis*, Waag. et Pichl., in a group of forms which he considered to be distinct from all the other congeneric species "by the circumstance that the two faces of the colony have very different aspects, on the poriferous side the fenestrules appearing more or less rectangular, while on the other side they appear oval or nearly circular."[1] Etheridge, in his description of *F. fossula* and of the very nearly allied *F. internata* (Palæontology of Queensland and New Guinea, p. 217), does not allude to this character, to which a special importance has been attributed by Waagen, but quotes *F. jabiensis* among the species which he believes to be most nearly allied to his Australian types. If Waagen's statement concerning the different aspect of the two faces in *F. fossula* and in *F. internata* is correct, my Himalayan species could not be included in the same group with them, because in this peculiarity it certainly does not agree with *F. jabiensis*. I consequently deemed it preferable to quote the present species as *sp. ind. aff. plebeia*, M'Coy, because its relationship to this European species appears to be more clearly established.

The propriety of referring to *Fenestella plebeia* a species which had been previously compared to *F. fossula* might perhaps be questioned in the face of Etheridge's statement that "the general appearance of *F. fossula* is quite different to that of *F. plebeia*," that "there is a total absence of the erect, rigid and wiry appearance so common to *F. plebeia*." In reality I think the two species to be very similar in their external shape, so far, at least, as I am able to judge from Etheridge's illustrations. There certainly exist differences between them as well as between *F. plebeia* and my Himalayan species, but they cannot be considered as very remarkable.

*Locality and geological position.*—Common in the Fenestella shales of Po and of the Losar Nullah. (Coll. Hayden and Krafft.)

---

[1] *W. Waagen*, Salt Range Fossils, Palæont. Indica, ser. XIII, vol. I, Productus Limestone Foss., p. 779.

### PROTORETEPORA AMPLA, Lonsdale.

1877. *Fenestella ampla*, Lonsdale, in Darwin's Geological Observations on volcanic Islands, etc., p. 163.
1899. *Protoretepora ampla*, Diener. Anthracolithic fossils of Kashmir and Spiti, Palæont. Indica, ser. XX, Himalayan Fossils, vol. I, pt. 2, p. 85, Pl. VII, fig. 10; Pl. VIII, figs. 1, 2.

For a complete list of synonyms the latter memoir may be consulted.

In the materials from the Fenestella beds of the Losar Nullah this species is represented by a sufficiently well-preserved example to warrant a certain identification. It is a cast of the poriferous side of the colony, with some fragments of the polyzoarium left undestroyed. It recalls the specimen which has been illustrated on Pl. VII, fig. 10, of my above-quoted memoir.

In all its characters this example agrees perfectly with my type-specimens from the Zewán beds of Kashmir, which had been collected by Lydekker.

*Locality and geological position: number of specimens examined.*—Fenestella beds, Losar Nullah: 1. (Coll. Hayden and Krafft.)

## B. FOSSILS FROM THE UPPER DIVISION OF THE ANTHRACOLITHIC SYSTEM.

[ABOVE THE GREAT UNCONFORMITY—PERMIAN SANDSTONES AND BLACK KULING SHALES.]

## AMMONOIDEA.

### XENASPIS cf. CARBONARIA, Waagen, Pl. VI, figs. 1—4.

1899. *Xenodiscus carbonarius*, Hayden. General Report, Geol. Surv. of India, 1898-1899, p. 48.

Among the fossils collected by Hayden in the Kuling shales near Danksa E. G. is a large number of fragments and casts of ammonites which have been attributed to this Salt Range species by their discoverer. On the whole this determination cannot be far wrong and accords pretty well with the figures and description given by Waagen of his type-specimens from the Salt Range Productus limestone. The materials are, however, I am sorry to say, too scanty to permit an absolutely decided identification.

The examination of the casts and fragments collected by Hayden and attributed to *Xenaspis* has, unfortunately, failed to discover the most remarkable character of the genus, namely the length of the body-chamber. None of the numerous fragments, which consist of remnants of the body-chamber only, amount to more than one-third of a volution.

As I have fully exposed my view as to the generic importance of the length of the body-chamber in the description of *Xen. carbonaria* from the permian limestone crag of Chitichun No. I in the first chapter of the present memoir, it will not be necessary to repeat what has been already written.

As the length of the body-chamber cannot be made out from the materials at hand, their determination must be based on characters of minor importance.

The fragments and casts available for examination are all of small size, none of the body-chamber whorls exceeding a height of 10 mm. The general shape of the shell is disciform, with numerous slowly-increasing volutions, which overlap each other but very slightly. The umbilicus is proportionally large and shallow, its diameter considerably exceeding the height of the last volution. The transverse section is more oval than cordiform or lanceolate. The largest transverse diameter is situated in the lower third of the height of the lateral parts. The latter are flatly and quite regularly arched, and gradually pass into the broadly rounded siphonal area. Neither marginal nor umbilical edges exist, but the distinctly developed and steeply inclined umbilical wall unites with the lateral parts in a strongly bent curve.

The sculpture, although subject to considerable variation, is very simple. The casts are either smooth or covered with numerous falciform striæ of growth, or they exhibit a rather irregular ornamentation, consisting of low and narrow transverse folds. This ornamentation is confined to the outer volution only.

The measurements of two specimens are as follows :—

| | | |
|---|---|---|
| Diameter of the shell . . . . . . . | 18 mm. | 22 mm. |
| " " umbilicus . . . . . . | 7·5 " | 9 " |
| Height of the last volution . . . . . . | 6 " | 7·5 " |
| Thickness " " " . . . . . . | 4 " | — |

*Sutures.*—In one single fragment, consisting of the proximal end of the body-chamber and four air-chambers, the sutural line has been partly preserved. The siphonal area having been slightly injured, I have not succeeded in developing the siphonal lobe. There is the normal number of principal lobes present, *i.e.*, two lateral lobes and one external and two lateral saddles. The vertical projection of the periphery of the penultimate whorl touches the apex of the lateral saddle in the last volution.

The external or siphonal, and the principal lateral, saddles are of equal height and breadth. The second lateral lobe is much shorter than the principal one. The second lateral saddle terminates at the umbilical suture and is followed by a sharply incised depression and by a short internal saddle which borders the deep and bicuspidate anti-siphonal lobe (funnel-lobe, Hyatt). The saddles are all provided with regularly rounded tops and parallel sides, and are shifted towards the umbilical part of the volution.

To the naked eye the lateral lobes appear nearly goniatitic or faintly serrated, but by means of a lens denticulations in the ogival arch, which forms the base of the principal lateral lobe, can be made out distinctly.

*Locality and geological position : number of specimens examined.*—Kuling shales, south of Danksa E. G., summit of high hill on right side of Rátang river, 7 ; north-north-west of Danksa E. G., left bank of Rátang river, 11. (Coll. Hayden.)

*Remarks.*—I have already pointed out that a direct identification of the fragmentary specimens collected by Hayden, with ***Xenaspis carbonaria***, Waag., rests on rather unsafe ground. There is undoubtedly a striking similarity between them, although slight differences may be noticed, the importance of which, however, must not be overrated.

The chief difference consists in the smaller size of the Himalayan specimens. A consequence of this difference in size is the more advanced development which the sculpture of the surface has reached in Waagen's type-specimens from the Salt Range Productus limestone.

As the length of the body-chamber is not accessible to observation in any of my Himalayan examples, it is impossible to decide, on the strength of this most important character, whether they really ought to be placed in the genus *Xenaspis* or should preferably be attributed to either *Ophiceras*, Griesb., or *Meekoceras* (*Gyronites*), Waagen. There is, however, no species of the two last-named genera to which the specimens in question bear such a striking similarity as they do to *Xenaspis carbonaria*.

Among the species of *Ophiceras*, *O. demissum* may certainly put in a claim for a closer comparison with the present form. This species has been fully described in my memoir on the Cephalopoda of the lower Trias (Vol. II, pt. 1, p. 121, Pl. XIV, figs. 1—7). Although they agree in their general shape and involution, a few slight but constant differences between them can be noticed. In *Ophiceras demissum* the largest transverse diameter is situated a little above the umbilical margin and the shape of its transverse section is consequently less oval than in the present species. The sculpture in *O. demissum* is more prominent, consisting of numerous delicate, narrow, falciform wrinkles, between which a few stronger ones are intercalated. A third difference exists in the arrangement of the sutural line, *O. demissum* being provided with a distinct auxiliary lobe, which either forms a straight, denticulated line or a regularly rounded arch. Thus the development of the sutures seems to prove clearly that an dentification of Hayden's permian species with *Ophiceras demissum* is not admissible.

From all the species of *Meekoceras* (*Gyronites*) which have been described from the ceratite formation of the Salt Range by Waagen, the present species is easily distinguished by remarkable details in the characters of involution, sculpture and sutural line.

It is to be regretted that the specimens collected by Hayden are too imperfect to allow a definite identification, although among all the forms with which they could be compared, *Xenaspis carbonaria* is certainly the nearest.

### CYCLOLOBUS, Waagen.

In 1879 Waagen introduced the genus *Cyclolobus*, for the accommodation of the famous ammonite which he had collected in the upper Productus limestone of Jabi and described as *Phylloceras Oldhami* in 1872, in the memoirs of the Geological Survey of India. In 1882 a species of rather doubtful systematic position was placed, although with some reserve, in this genus by E. v.

Mojsisovics (Die Cephalopoden der Mediterranen Triasprovinz, Abhandl. K. K. Geol. Reichs-Anst., Bd. X, p. 165). The propriety of classing this triassic species with *Cyclolobus* is indeed questionable. A true representative of Waagen's genus, however, has been mentioned from the permian rocks of Timor by Rothpletz and described as *Arcestes* (*Cyclolobus*) *persulcatus* (Palæontographica, 39 Bd., p. 88, pl. IX, fig. 5). Each of the two species of the genus is at present represented by only a single specimen.

A considerable number of representatives of the genus *Cyclolobus* has been collected by Hayden and A. v. Krafft in the uppermost division of the Kuling shales of Spiti. Most of the specimens were found as nuclei of concretions exactly like the fossils from the jurassic Spiti shales. Among the rich materials from the upper Kuling shales of Spiti four species can be distinguished, but the characters of none are entirely known to me.

It is a well-known fact that in the family of *Arcestidæ* specific determinations are more difficult than in any other group of triassic and permian ammonites. For complete diagnosis of the species both chambered nuclei of inner volutions and full-grown individuals provided with their body-chambers must be available for examination. This demand can be fulfilled only if very rich materials are at hand and if one is enabled to sacrifice freely a number of examples in order to develop their inner nuclei by gradually destroying the body-chamber. The Himalayan materials entrusted to me for description are too precious to allow this method of examination; I must consequently abstain from an attempt to arrive at a satisfactory diagnosis of every species, and must leave their description to a certain extent incomplete. Nevertheless I hope that the distinction of four species among my Himalayan materials will be found to be correct, and that our knowledge of the generic characters of *Cyclolobus* has been considerably advanced by the study of the sutures of *C. Kraffti* and of the body-chambers of *C. insignis* and *C. Haydeni*.

One of these four Himalayan species is very nearly allied to *C. Oldhami*, Waagen, and perhaps identical with this Salt Range form, although the imperfect state of preservation does not permit a decided identification.

A second species is represented by one single, full-grown specimen, provided with its body-chamber and distinguished by numerous (five) contractions which are not restricted to the umbilical portion of the shell as in *C. Oldhami*, but reach across the siphonal part in strongly backward-bent curves. Neither the inner volutions nor the sutures of this species, for which the name of *C. insignis* is introduced, are known to me.

The third species is represented by inner volutions only. The absence of varices and the arrangement of the sutural line are distinctive characters of this species, for which I propose the name of its discoverer, Dr. A. v. Krafft.

Of the fourth species, which in future will bear the name of *Cyclolobus Haydeni*, both nuclei of inner volutions and full-grown specimens with body-chambers are available for examination. The sutures, however, are but imperfectly known to me. The inner volutions of this species differ from those in *C. Kraffti* by the presence of varices, which occur to the maximum number of three in one volution.

The body-chamber is smooth, without any contractions, differing in this respect entirely from *C. Oldhami* or *C. insignis.*

The specific distinction of *C. insignis* and *C. Kraffti* might perhaps be questioned, as the possibility of *C. Kraffti* being the nucleus of *C. insignis* cannot be denied with absolute certainty. There is, however, strong evidence against this view, which to me appears to rest on very unsafe ground.

Besides these four species which I have been able to recognise among the Himalayan materials of *Cyclolobus* collected by Hayden and Krafft, a number of examples were met with which did not permit a specific determination. Specimens of this sort were collected in the black shales of the Kuling series at Kuling, Lilang, Gaichund and near the Rátang river.

Some of my new Himalayan species of *Cyclolobus*, to which *C. Walkeri* from the permian limestone crag of Chitichun No. I must be added, are, in the arrangement of their sutures, distinguished from the prototype of the genus, *C. Oldhami*, Waagen, by a feature which, in the eyes of some palæontologists, (of my learned colleague A. Hyatt, for instance) might probably appear to be of generic, or at least sub-generic, importance. This peculiar feature consists in the ramification of the siphonal saddle, which by the development of outer branches becomes more complicated than the remaining saddles, and thus makes an exception from the serial arrangement of the sutural elements. Now this serial arrangement of the sutures is one of the leading features in the family of *Arcestidæ*. Thus there seems to be some reason for proposing a proper genus for the accommodation of those species of *Cyclolobus* which possess a siphonal saddle, differing from the other saddles by its more complicated ramification.

I do not, however, agree with this view. The close relationship of the Himalayan species of *Cyclolobus* to the permian *C. Oldhami* from the Salt Range is so obvious that the dissimilarities in the arrangement of the siphonal saddles are, in my opinion, of too little value to justify a generic separation.

If the characters of distinction by which this group of forms differs from *Cyclolobus Oldhami* should be considered as of sub-generic importance, the sub-generic appellation of *Krafftoceras* is proposed for them.

### CYCLOLOBUS cf. OLDHAMI, Waagen, Pl. VI, fig. 6.

1900. *Cyclolobus cf. Oldhami*, Hayden. General Report, Geol. Surv. of India, 1899-1900, p. 190.

The single specimen by which this species is represented in the Himalayan collection is too fragmentary to permit a specific identification with *Cyclolobus Oldhami*, Waagen (Salt Range Foss., Palæont. Indica, ser. XIII, vol. I, Productus Limestone Fossils, p. 24, Pl. I, fig. 9), to which it is, at least, very nearly allied. The fragment is a water-worn cast, almost one-half of which has been broken away, the umbilicus, however, having been entirely left. The termination of the last whorl nearly coincides with the commencement of the body-chamber.

In general shape, size, and involution the present fragment strongly recalls *Cyclolobus Oldhami*. It has compressed, lenticular whorls, which increase more slowly than in any other species of *Cyclolobus*. *C. Oldhami* is the only hitherto known species of the genus, in which the involution of the whorls is so considerable that nearly two-thirds of the room within the last whorl is filled up by the preceding volution. In Waagen's type-specimen of *C. Oldhami* the height of the last volution from the umbilical suture is 55 mm., from the siphonal part of the penultimate whorl 20 mm. only. In the present specimen the corresponding measurements are 48 to 19 mm. This proportion is most nearly approached by *C. persulcatus*, Rothpletz (23 to 9 mm.). The umbilicus likewise exhibits the same size and character as in *C. Oldhami*. The involution does not take place exactly on the umbilical margin of the preceding whorl. A narrow strip of the lateral parts of the inner volutions, separated by low, vertical walls, is consequently exposed inside the umbilicus.

The perpendicular umbilical wall unites with the flatly but regularly curved lateral parts in an obtusely rounded-off umbilical edge. The siphonal part is broadly rounded and passes gradually into the lateral parts.

The surface of the cast exhibits a small number of varices. Five of them I am able to count, but as the fragment is partly water-worn, a larger number may actually have been present in the perfect shell. The varices reach from the umbilical suture, in the shape of falciform curves, to the siphonal part, which they do not cross. The backward-bent portion of the falciform curve is situated on the upper part of the flanks.

Traces of a faint ornamentation are visible within the umbilical region. This ornamentation consists of very low and short folds, which are well expressed only in the vicinity of the umbilical suture, and are completely obliterated on the lateral parts a short distance outside the umbilical margin.

Of the shell substance a few small fragments have been preserved, which are covered by numerous and delicate striations. Waagen's type-specimen of *Cyclolobus Oldhami* being a cast without any trace of its shell, the external ornamentation of the genus had hitherto remained unknown.

The measurements of the fragment under description are as follows :—

| | | | |
|---|---|---|---|
| Diameter of the shell | | 94 | mm. |
| ,, ,, | umbilicus | 14 | ,, |
| Height of the last volution | from the umbilical suture | 48 | ,, |
| | ,, siphonal part of the preceding whorl | 19 | ,, |
| Thickness of the last volution | | 29 | ,, |

*Sutures*.—The sutural line is too imperfectly visible and the details of the sutures have been too badly injured by weathering to describe them in a satisfactory manner. Their general character and, especially, their semicircular, or rather, parabolic arrangement is, however, clearly marked.

The siphonal lobe is not accessible to observation. The periphery of the penultimate whorl touches the apex of the second lateral saddle in the last volution. Two lateral lobes and saddles are consequently present. The siphonal and the two lateral saddles are tolerably well exposed in the last suture at the beginning of the body-chamber (fig. 6 *c*), but all the details of ornamentation have disappeared owing to the weathering of the cast. If we make exception for this difference, which is satisfactorily explained by the state of preservation of our fragment, the general shape of the saddles is not opposed to an identification of Hayden's specimen with *C. Oldhami.*

In the penultimate whorl the two lateral saddles and the principal lateral lobe have been found in a better state of preservation (fig. 6 *d*). They agree fairly well with the corresponding sutural element in *C. Oldhami*. The apex of each saddle is formed by a single roundish phyllum, the longer diameter of which is at right angles to the axis of the saddle and parallel to the numerous branches which adorn the stem of the latter. The principal lateral lobe shows a tripartite arrangement of its denticulations, the central one being deepest.

Of the auxiliary series only very imperfect traces have been preserved, and are not fit for description.

*Locality and geological position: number of specimens examined.*—Seven miles north-north-west of Kágá, black Kuling shales : 1. (Coll. Hayden.)

### CYCLOLOBUS INSIGNIS, nov. sp., Pl. VI, fig. 5.

This beautiful species is represented by a single but excellently preserved specimen, the last volution of which is made up entirely of the body-chamber. Attempts to sever the body-chamber from the chambered nucleus have convinced me that the inner volutions are filled up with so spathic a matrix that there is no chance of making the sutural line accessible to observation. The diagnosis of the species must consequently be incomplete, two important features, namely, the character of the chambered nucleus and the arrangement of the sutures, remaining unknown.

In its general shape and involution the present species differs from *C. Oldhami*, by more rapidly increasing whorls and by the small size of the umbilicus. The height of the penultimate whorl is exactly one-half the height of the last volution.

The transverse section is lanceolate and considerably higher than broad. Its greatest transverse diameter is situated a little above the umbilical margin. The lateral parts converge from this point towards the siphonal area as very slightly, but regularly, arched planes. The siphonal part is broadly rounded and passes very gradually into the lateral parts. The lateral parts slope gently towards the umbilical margin from the point where the transverse diameter is greatest. The umbilical margin is distinctly marked off from the flanks, and takes the shape of an obtusely rounded-off edge. The umbilical wall is very steep. The umbilicus is deep and funnel-shaped and considerably smaller than in *C. Oldhami*. As the involution takes place exactly at the umbilical suture, no strips of the inner volutions are exposed inside the umbilicus.

Contractions can be observed to the number of five in the last volution. They are of very remarkable shape. Among the family of *Arcestidæ* I do not know of any species with so complicated contractions. They rise at the umbilical margin with a radial direction, are then strongly bent forward, describe a backward-bent curve corresponding to the middle of the height of the lateral parts, are once more bent forward a little below the siphonal margin and cross the siphonal area in a backward-bent, deeply sunk curve. Thus from the umbilical margin to the median line of the siphonal area they describe an undulating curve, the convexity of which is twice turned backward and twice forward. The transverse section of the contractions is quite regular, no trace of "imbrication," in the sense in which this term is employed by E. v. Mojsisovics (Cephalopoden der Mediterranen Triasprovinz, p. 12) having been noticed.

The shell substance is well preserved and exhibits numerous delicate growth-lines, which follow the direction of the contractions and are occasionally arranged in bundles. It is the same system of ornamentation as has been described by Gemmellaro in the majority of species belonging to the genera *Waagenoceras* and *Popanoceras*.

The measurements of my type-specimen are as follows:—

| | | | |
|---|---|---|---|
| Diameter of the shell | | 66 | mm. |
| " " " umbilicus | | 9 | " |
| Height of the last volution | from the umbilical suture | 36 | " |
| | " " siphonal part of the preceding whorl | 18 | " |
| Thickness of the last volution | | 25 | " |

*Locality and geological position: number of specimens examined.*—Kuling shales, Lilang: 1. (Coll. Krafft.)

*Remarks.*—In addition to this type-specimen the fragment of an external impression of a *Cyclolobus* from the Kuling shales north-north-west of Kágá (coll. Hayden) is in the Himalayan collection. This fragment, in which auxiliary lobes and saddles have been partly preserved, probably belongs to *C. insignis*, but its identification is doubtful on account of the unsatisfactory state of preservation.

### CYCLOLOBUS (KRAFFTOCERAS) KRAFFTI, nov. sp., Pl. VI, fig. 9.

Of this remarkable species only chambered nuclei, consisting of inner volutions, but no body-chambers, have been found among the materials collected by Dr. A. v. Krafft in the Kuling shales of Spiti. Thus its diagnosis must necessarily remain incomplete, although the correctness of considering it to be a proper and well characterized species can barely be questioned.

My type-specimen, which consists of air-chambers only, is but very little inferior in size to the type-specimen of *Cyclolobus insignis*, the last volution of which is made up entirely by the body-chamber. The perfectly preserved type of the present species must consequently have been at least twice as large as *C. insignis*. In general outline and involution the two species are similar, but they differ considerably in the shape of the umbilicus, which in the present species is very narrow and not deep.

The cast is entirely smooth and devoid of any varices or contractions.

No fragment of the shell substance has been preserved on the surface of the last volution, but by clearing off a small portion of the penultimate whorl from the overlapping volution I was able to expose the shell, which proved to be smooth.

But the question to be decided is whether the examination of so small a fragment of shell substance should be considered sufficient to deny the presence of any ornamentation.

The measurements of the figured type-specimen are as follows:—

| | |
|---|---|
| Diameter of the shell | 68 mm. |
| ,, ,, umbilicus | 4 ,, |
| Height of the last volution from the umbilical suture | 36 ,, |
| ,, ,, ,, ,, siphonal part of the preceding whorl | 17 ,, |
| Thickness of the last volution | 26 ,, |

*Sutures.*—The most characteristic feature of this species is its sutural line.

The vertical projection of the periphery of the penultimate whorl touches the apex of the third lateral saddle in the last volution. Thus the species is undoubtedly provided with three lateral lobes and saddles, followed by seven or eight auxiliary lobes and saddles. In the diagnosis of the genus *Cyclolobus* the number of lateral lobes must now be eliminated from the characters of generic importance, three lateral lobes being present in *C. Kraffti* and in *C. Walkeri*, but two only in *C. Oldhami*.

In the parabolic arrangement of the sutural elements, especially in the strongly curved umbilical branch of the parabolic arch, *C. Kraffti* closely resembles Waagen's type of the genus. In the details of the sutural line remarkable differences are, however, noticed.

The siphonal lobe is the deepest and largest of all. It is divided by a very high and broad median prominence, which in size nearly equals the siphonal and principal lateral saddles. In the development of the siphonal saddle an extraordinarily rich ramification predominates. In this saddle three deeply incised outer branches are so strongly individualised, that it is merely a matter of convenience whether the lowest branch should be regarded merely as a secondary element of the siphonal saddle or as a proper adventitious saddle. By this individualisation of its outer secondary branches the siphonal saddle differs remarkably from the remaining saddles, which represent a type of suture, to which the term "serial" has been applied by Blake (Proceed. Geol. Association, XIII, pt. 2, 1893, p. 2).

Whereas the lateral and auxiliary saddles recall in their shape and arrangement the corresponding sutural elements in *C. Oldhami*, the lateral lobes are distinguished by their bipartite character. In *C. Oldhami* the lateral and auxiliary lobes are tripartite, the median indentation being deepest. In the present species each single lobe is divided into two branches, which are provided with secondary indentations and are separated by a large median prominence. I cannot assert positively whether this character holds good in the auxiliary series also, as the minor details of the very small auxiliary lobes are not visible.

*Locality and geological position: number of specimens examined.*—Kuling shales, Lilang, 2 (coll. Krafft); two miles below Tanga Chenmo E. G., Gyundi river, 1 (coll. Hayden).

*Remarks.*—In the development of the sutural line and the absence (?) of varices this species appears to be more nearly allied to *Cyclolobus Walkeri* from the permian limestone crag of Chitichun No. I than to *C. Oldhami*, Waagen.

In *C. Oldhami* all the sutural elements represent a serial type of sutures. In *C. Walkeri* and in *C. Kraffti* the siphonal or external saddle differs from the remaining saddles in its greater complication. Whereas in *C. Walkeri* it becomes bipartite by developing a secondary outer branch, as in *Joannites*, its complication is far more advanced in *C. Kraffti* by the individualisation of three outer branches, one of which almost assumes the part of a proper adventitious saddle. For the accommodation of these two species the diagnosis of the genus *Cyclolobus* must consequently be somewhat modified, an exception from the serial arrangement of sutures being made for the siphonal saddle.

When first studying the species of *Cyclolobus* from the Himalayan collection, I noticed another point of difference from *C. Oldhami*, which seemed to me of no small importance. Having compared the sutural lines of my Himalayan species with that of *C. Oldhami*, as given by Waagen in his monograph on the fauna of the Salt Range Productus limestone (l. c., Pl. I, fig. 9 *c*), I could not find in any of them a fan-shaped siphonal lobe with numerous indentations of equal size, but have always found the siphonal lobe divided by a very large median prominence. As the presence of a median prominence, assuming the character of a proper saddle, might have been rightly considered as a character of at least sub-generic importance, Mr. C. L. Griesbach, Director of the Geological Survey of India, at my especial request kindly examined Waagen's type-specimen in Calcutta and furnished me with a few additional illustrations, in which certain parts were more exactly illustrated than in Waagen's original drawing.

The point to which I should desire to direct more particular attention is the very bad state of preservation of the siphonal area in Waagen's type-specimen of *C. Oldhami*. According to Griesbach's statement, the median portion of the siphonal lobe is not visible. To him Waagen's interpretation of its shape does not appear to be based on any direct observation. From the drawings which Mr. Griesbach kindly sent me it is evident that Waagen was not acquainted with the true character of the siphonal lobe in *Cyclolobus Oldhami*. It is, therefore, still uncertain whether or no this lobe was provided with a large median prominence as in the congeneric species from the permian Kuling shales of the Himalayas.

The question might be raised whether *Cyclolobus Kraffti* could not be considered the inner nucleus of *C. insignis*. But I do not think this suggestion appropriate to the true character of both these species. If we compare the type-specimens of *C. Kraffti* and *C. insignis*, which are both of nearly equal size, it will be seen that in the shape of the umbilicus they differ so remarkably, that it is impossible for me to admit the propriety of placing them in the same species.

### CYCLOLOBUS (KRAFFTOCERAS) HAYDENI, nov. sp., Pl. VI, figs. 7, 8.

This is the only species of the genus *Cyclolobus* in which the two most important stages of development—chambered nuclei and full-grown individuals with body-chambers—are both known to me. On Pl. VI, I have given views of both stages in order to satisfy the reader of the correctness of this assertion.

*Cyclolobus Haydeni* does not attain so large dimensions as the congeneric species hitherto described. In this respect it resembles *C. persulcatus*, Rothpletz (Die Perm. Trias und Juraformation auf Timor und Rotti, Palæontographica, 39 Bd., p. 88, Taf. IX, fig. 5), from the permian rocks of Timor. The specimen figured on Pl. VI, fig. 7, is a full-grown, longidome individual, the last volution of which belongs entirely to the body-chamber. In its general shape and involution it is very nearly related to *C. Kraffti*. With this species it likewise agrees in the character of the narrow and funnel-shaped umbilicus. Its transverse section is a little more strongly compressed and its largest transverse diameter nearly coincides with the umbilical margin.

The surface of the cast is perfectly smooth and not provided with varices or contractions. The shell is covered with very numerous delicate striæ of growth. The falciform growth-lines describe a crescent-shaped curve, convex forward, on the lower portion of the lateral parts, and a second less strongly-bent curve, with its convexity turned backward, on the upper portions of the flanks. In the immediate vicinity of the siphonal margin the striations are turned forward but do not keep this direction in crossing the siphonal area.

The richer materials of this species have enabled me to develop the inner nucleus by scaling off the entire body-chamber of an example which had been originally slightly inferior in size to the type-specimen above described. This chambered nucleus, an illustration of which has been given in fig. 8, differs from the body-chamber by the presence of three varices. The varices run parallel to the lines of growth and cross the siphonal area in a strongly backward-bent curve.

The measurements of my type-specimens are as follows:—

| | | I.<br>(Fig. 7.) | II.<br>(Fig. 8.) |
|---|---|---|---|
| Diameter of the shell | . . . | 57 mm. | 26 mm. |
| " " " umbilicus | . . . | 4·5 " | 2 " |
| Height of the last volution | from the umbilical suture . . | 34 " | 16 " |
| | from the siphonal part of the preceding whorl . | 17 " | 8 " |
| Thickness of the last volution | . . | 23·5 " | 15 " |

With the present species are identified a small number of chambered nuclei, which differ from *C. Kraffti* by the presence of varices. They are closely allied to *C. persulcatus*, Rothpl., but are distinguished from that species by a smaller number of varices, which does not exceed the number of three in any of my Himalayan specimens, whereas four varices are counted in *C. persulcatus*.

*Sutures.*—I am, unfortunately, not able to give an adequate illustration of the sutural line, as it is only partly visible in one of my specimens which has a diameter of 16 mm. The siphonal lobe and saddle, which I have succeeded in rendering entirely visible, are of the same type as in *C. Kraffti*. The siphonal lobe is provided with a large median prominence, the siphonal saddle with distinctly developed outer branches. Thus *C. Haydeni* must be classed among the species of the genus ***Cyclolobus***, in which the siphonal or external saddle makes an exception from the serial arrangement of the sutural elements.

*Locality and geological position: number of specimens examined.*—Black Kuling shales, Kuling, 2 (coll. Krafft); Lilang, 1 (coll. Krafft); Rátang river, 1 (coll. Hayden); south-east of Po, 3 (coll. Hayden).

## NAUTILOIDEA.

### ORTHOCERAS, sp. ind., Pl. VIII, fig. 2.

A few fragments of *Orthoceras* have been recorded from the Kuling shales of Spiti. One fragment, consisting of three air-chambers, indicates a species of comparatively large size. Otherwise this specimen is not fit for a specific determination.

To a diameter of 34 mm. a distance of the septa of 7·5 mm. corresponds. The septa are strongly convex. The position of the siphuncle is central.

There is no species to which the present one might be advantageously compared. *Orthoceras campanile* (E. v. Mojsisovics, Cephalopoden der Mediterranen Triasprovinz, p. 291, Pl. XCIII, figs. 1—4, 11), from the triassic rocks of the Alps and Himalayas, with which it agrees in the very small angle of emergence, is provided with more distant septa in specimens of a similar size.

*Locality and geological position: number of specimens examined.*—Kuling shales, north-west of Muth: 1. (Coll. Krafft.)

### NAUTILUS (GRYPOCERAS), sp. ind., Pl. VIII, fig. 1.

The single, entirely chambered fragment, by which this species is represented in the Kuling shales of the Himalayas, recalls some triassic forms of *Nautilidæ*, for which the genus *Grypoceras* has been proposed by Hyatt (Genera of fossil cephalopoda, Proceedings, Boston Soc. of Nat. History, vol. XXII, 1883, p. 269). The triassic species, which appear to be nearly allied to the present one, are *Nautilus quadrangulus*, Beyrich, from the Alpine Muschelkalk, and *N. brahmanicus*, Griesb., from the Himalayan Otoceras beds. From both of them the fragment under consideration is, however, specifically distinct.

The whorls barely overlap each other and have a quadrangular cross-section. The volutions are remarkably broader than high, the greatest breadth coinciding with the siphonal margins, which are sharply rounded. From the rounded umbilical margin the sides slope in a regularly steep, but not vertical, wall towards the umbilicus. The siphonal area is broadly convex.

The surface of the cast is entirely smooth. Of the shelly substance no traces have been preserved. The siphuncle is situated below the centre.

The measurements of this fragment are as follows:—

| | | |
|---|---|---|
| Height of the volution | from the umbilical suture | 19 mm. |
| | " " siphonal part of the preceding whorl | 16 " |
| Thickness of the volution | | 24 " |

*Sutures.*—The septa are closely arranged, less distant than in *Nautilus quadrangulus.* A broad and shallow ventral lobe is followed by a distinctly developed saddle, the apex of which coincides with the sharply rounded-off siphonal edge. Lateral lobe broad and deep. A flat lateral saddle is situated on the umbilical margin. Whether or not an annular lobe was present, cannot be ascertained.

This arrangement of the sutural line, together with the general shape of the fragment, proves the latter to be a typical representative of the genus *Grypoceras* which has hitherto been described from triassic beds only.

*Locality and geological position: number of specimens examined.*—Kuling shales, north of Po: 1. (Coll. Krafft.)

## LAMELLIBRANCHIATA.

### OXYTOMA LATICOSTATUM, Netschajew, Pl. VIII, fig. 10.

1894. *Pseudomonotis laticostata,* Netschajew. The fauna of the permian deposits of the Eastern portion of European Russia, Trudy Soc. of Nat., Imper. University of Kasan, T. XXVII, pt. 4, p. 215, Pl. VII, figs. 7, 8.

Two casts of the left valve of this species are known to me, one of them being well preserved and almost complete. It is of roundish oval outlines, strongly inflated, and but very slightly oblique. The apex is acute, projects beyond the hinge-line and is strongly incurved. Of the wings the anterior one only has been preserved. It is small and obtusely angulate.

The most characteristic feature of this species is its sculpture. It consists of two kinds of radiating ribs. The ribs of the first order, occurring to the number of ten to twelve, are simple, thin, rounded above, and of equal thickness throughout their extension from the apical region to the ventral margin. Their width does not exceed half a millimetre. The ribs of the second order are regularly disposed between those of the first order. They likewise originate in the apical region as thin, rounded elevations, but rapidly increase in height and width as they approach the ventral margin, where their breadth is 1·5 to 2 mm. There they terminate as strong costæ, with rounded tops and regularly sloping sides, and are separated by deep valleys or furrows from the ribs of the first order. To the latter correspond sharp, thorny processes, which project from 2·5 to 3·5 mm. from the margin of the shell. Thus the whole periphery of the shell, with the exception of the hinge-line, is provided with strong indentations.

The measurements of the figured specimen are as follows:—

| | |
|---|---|
| Entire length of the shell | 23 mm. |
| " height " " " | 24 " |
| Thickness of the left valve | 9 " |
| Apical angle | ca. 80° |

This specimen entirely agrees in all its characters with the Russian examples of *Pseudomonotis laticostata* from the permian rocks of Bogorodskoie, which have been described and illustrated by Netschajew. This author has been perfectly right in stating the very intimate relationship which his species bears to *Oxytoma atavum*, Waagen (Salt Range Fossils, Palæontologia Indica, Ser. XIII, Vol. I, Productus limest. Foss, p. 287, Pl. XX, figs. 6, 7). Of both species left valves only are at present known, although Netschajew erroneously designates his examples as right valves.

The following features of distinction between the Russian and the Salt Range form are enumerated by him: *Pseud. laticostata* is less oblique, more strongly inflated, and provided with an acute and more prominent apex. In all these characters my Himalayan specimens likewise differ from *Oxytoma atavum*. The barely oblique shape and the small apical angle (80° in *O. laticostatum*, 120° in *O. atavum*) are specially remarkable.

From *Aviculopecten duplicicostatus*, Netschajew (l. c., p. 206, Pl. VI, fig. 16), which in its peculiar sculpture strongly recalls *O. laticostatum*, as has been remarked by Netschajew, the latter species is distinguished by the different shape of the cardinal region.

*Locality and geological position: number of specimens examined.*—Sandstone underlying Kuling shales, north of Po, 1 (coll. Hayden and Krafft); Kuling shales with *Bellerophon*, south of Pomarang, 1 (coll. Krafft).

*Remarks.*—There is much discrepancy of opinion as to the advisability of retaining *Oxytoma*, Meek, as a proper genus among the family of *Aviculidæ*. A sharp distinction of the forms belonging to *Oxytoma* from *Pseudomonotis*, Beyr., is impossible, as has been stated both by Stoliczka, who advocates that the two genera should be united, and by Waagen, who prefers to keep them separate. I follow in the path of Waagen and Teller (Arktische Triasfaunen, Mém. Acad. Impér. des sciences de St. Pétersbourg, T. XXIII, No. 6, 1886, p. 128) in retaining the name *Oxytoma* for those extremely inequivalve *Aviculidæ*, of which the strongly inflated left valves are covered with stout costæ occasionally projecting beyond the margin, whereas the flat right valves with a deep byssal sinus are provided with radial furrows,—not with prominent ribs.

### AVICULOPECTEN, sp. ind., Pl. VIII, fig. 3.

The only specimen of *Aviculopecten* from the permian rocks of Spiti in Hayden's and Krafft's Himalayan collection is a single cast of a left valve of medium size, considerably inflated and strongly inequilateral. It is obliquely oval and about as long as high. The apex is anterior in its position, projecting slightly beyond the long hinge-line, and acute. It is limited on both sides by large wings, the cardinal angles of which have not been entirely preserved. The wings are of unequal size, the anterior being smaller than the posterior. It is on the strength of this character that the shell has been attributed to the genus *Aviculopecten*.

The anterior wing, though only partly preserved, did certainly project far in front of the anterior margin, from which it is separated by a sharply rounded, deep sinus. The posterior margin is continuous, not sinuated at the commencement of the posterior wing. It is likewise continuous with the broadly arched ventral margin, which unites with the anterior one in an obtusely rounded-off angle.

Both wings are marked off distinctly from the remainder of the shell. The anterior marginal edge slopes in a perpendicular wall towards the surface of the anterior wing. Towards the posterior wing the shell is less steeply inclined, and the furrow separating them is less sharply defined.

The apical angle nearly coincides with the angle included between the lines connecting the apex with the terminal points of the ventral shell-margin. It is acute. Measurements of the length of the hinge-line cannot be given, but it is certainly not much inferior to the antero-posterior diameter of the shell.

The sculpture recalls *Aviculopecten hiemalis*, Salter, but is more irregular. The surface is ornamented by two or three different classes of ribs. There are about thirteen principal costæ, which rise in the apex, are equidistant, prominent, and steeply rounded on their tops. Between each two of them there is one, or occasionally two smaller, linear ribs, which die out before reaching the apical region. A third class of rib is formed by some of the principal costæ becoming dichotomous in the vicinity of the ventral margin. A distinct concentric sculpture has not been noticed.

The posterior wing is covered with numerous thin radiating striæ. The anterior wing seems to have been perfectly smooth.

The measurements of this specimen are as follows :—

| | |
|---|---|
| Antero-posterior diameter | 35 mm. |
| Apico-ventral diameter | 37·5 „ |
| Thickness of the left valve | 10 „ |
| Apical angle | 78° |

*Locality and geological position : number of specimens examined.*—Sandstones underlying Kuling shales, north of Po : 1. (Coll. Krafft and Hayden.)

*Remarks.*—In its ornamentation this species resembles *Aviculopecten hiemalis* and its allies, but differs radically from that group of forms by its strongly inequilateral outlines, by the larger dimensions of its wings, and by the nearly straight, not sinuated, configuration of the marginal edges connecting the apex with the terminal points of the ventral shell margin.

I do not know any species of the genus *Aviculopecten* to which the present one might be advantageously compared.

### MODIOLOPSIS TEPLOFI, Vern., Pl. VIII, fig. 6.

1845. *Mytilus Teplofi*, E. de Verneuil. Géologie de la Russie de l'Europe, Vol. II, pt. 3, Paléontologie, p. 318, Pl. XIX. fig. 17.
1860. *Modiolopsis Teplofi*, Eichwald. Lethæa Rossica I, p. 978.
1874. *Modiola Teplofi*, Trautschold. Die Kalkbrueche von Miatschkowa, p. 45, Taf. IV, fig. 24.
1894. *Modiolopsis Teplofi*, Netschajew. Die Fauna der permischen Ablagerungen des œstlichen Theiles des europæischen Russlands, Trudy Soc. of Naturalists Imp. University of Kasan, T. XXVII, pt. 4, p. 233, Pl. VIII, figs. 5, 6, 10—13.

As has been stated by Netschajew, *Modiolopsis Teplofi*, Vern., and *Mod. Pallasi*, Vern. (l. c., p. 316, Pl. XIX, fig. 16), are connected by many intermediate shapes, but typical representatives of both species differ in the following characters: *Mod. Teplofi* is of larger size, its ventral margin is not rounded, as in *Mod. Pallasi*, but nearly straight, and unites with the rounded lateral margins in obtuse angles. The apex is not terminal, is less anterior in its position than in *Mod. Pallasi*, and only slightly incurved. From the apex to the posterior margin an obtusely rounded ridge or keel runs across the convex surface of the shell.

In all their characters accessible to observation my Himalayan examples agree with typical specimens of *Mod. Teplofi*. The ventral and posterior margins have not been entirely preserved, but in the rest of its features my figured type-specimen from the Kuling shales of Pomarang is a typical representative of the Russian species.

It is of large size, very strongly inequilateral, transversely elongate, with a narrower anterior and a broader posterior margin. The small, prosogyrate, slightly incurved beak overhangs a small and moderately deep lunula. The rounded anterior margin is slightly prominent beyond the apex. The obtusely rounded ridge which separates the steeply inclined posterior, from the flatly arched anterior, portion of the valve, is very distinctly developed.

My specimens are internal casts with a nearly smooth surface which is ornamented only by indistinct and irregularly disposed ridges of growth. No traces of the shell substance have been preserved.

In the illustrated example the septum below the apex, which separates the anterior adductor scar from the interior surface of the valve, is marked by a sharp impression.

Exact measurements of this specimen cannot be given. The illustration will convey, I hope, a sufficiently clear idea of its features.

*Locality and geological position: number of specimens examined.*—Kuling shales south of Pomarang: 2. (Coll. Krafft.)

*Remarks.*—*Modiolopsis Teplofi* is a common species in the anthracolithic rocks of Russia, ranging from upper carboniferous (limestone of Miatschkowa) into permian strata.

### SOLEMYA (JANEIA) BIARMICA, Vern., Pl. VIII, figs. 7, 8.

1845. *Solemya biarmica*, E. de Verneuil. Géologie de la Russie d'Europe, Vol. II, pt. 3, Paléontologie, p. 294, Pl. XIX, fig. 4.
1846. *Solemya biarmica*, Keyserling. Wissenschaftliche Beobachtungen auf einer Reise in das Petschoraland, p. 254.
1854. *Solenomya Phillipsiana*, Schauroth. Zeitschr. Deutsch. Geol. Ges., Bd. VI, p. 553, Taf. XXI, fig. 5.
1861. *Solemya biarmica*, Geinitz. Die Dyas, p. 60, Taf. XII, figs. 18, 19.
1868. *Solemya biarmica*, Golowkinsky. The permian system of the Kama-Wolga basin (in Russian). Materialien zur Geologie Russlands, Bd. I, p. 94, Pl. IV, fig. 17.
1885. *Solemya biarmica*, Tschernyschew. Der permische Kalkstein im Gouvernement Kostroma, p. 14, Taf. XVI, figs. 21, 22.
1885. *Solemya biarmica*, Krotow. Artinskian stage (in Russian), Trudy Soc. of Naturalists, Imper. University of Kasan, T. XIII, Pt. 5, p. 251.
1894. *Solemya biarmica*, Netschajew. Die Fauna der permischen Ablagerungen des œstlichen Theiles des europæischen Russlands, *ibidem*, T. XXVII, pt. 4, p. 302, Pl. X, fig. 15.

The most complete description of this species,—one of the leading fossils of the permian rocks of Eastern Russia and of the lower Zechstein of Germany,—has been given by Geinitz and Golowkinsky. Among the Himalayan collection there are two specimens which so closely agree with the illustrations published by these authors, that I do not hesitate in identifying them with *Solemya biarmica*, Vern.

The larger of my two specimens is an internal cast of a left valve, without any trace of shell. It is transversely elongate, twice as long as high, strongly inequilateral, with a narrow anterior and a broad posterior margin. The low apex corresponds in its position to the anterior third of the entire length of the shell. The valve is regularly vaulted. Its surface is covered with numerous obscure wrinkles, running parallel to the free margins. A deep furrow runs from the apex along its anterior side for some distance. It unites in the apex with a second furrow running parallel to the upper margin. These two furrows or impressions are yet more distinctly exhibited in my second example, in which a triangular space is marked off by them, corresponding to the anterior adductor scar. This internal arrangement completely agrees with the illustrations given by Geinitz.

In my second specimen the shell substance has been partly preserved. It is thin, covered externally with numerous concentric striæ of growth, and with a few delicate, radiating lines emanating from the apex and diverging towards the posterior margin.

The measurements of my larger specimen are as follows :—

| | |
|---|---|
| Entire length of the shell | ca. 27 mm. |
| „ height „ „ | „ 13 „ |
| Thickness of the left valve | „ 4·5 „ |

*Locality and geological position: number of specimens examined.*—Kuling shales, south of Pomarang: 2. (Coll. Krafft.)

*Remarks.*—It has been stated by Geinitz that the internal arrangement of this permian species entirely agrees with that noticed in the recent *Solemya* by Deshayes. It is, however, suggested by Dall (in Zittel's Textbook of Palæontology, p. 361) that most of the palæozoic species hitherto referred to *Solemya* might be more advantageously included in the genus *Janeia*, King (Monograph of the permian fossils of England, p. 177), as they differ from the recent *Solemya* by being shorter and less inequivalve.

### MYTILUS, sp. ind., Pl. VIII, fig. 4.

A typical species of *Mytilus* from the upper Productus limestone of the Salt Range has been described by Waagen (Salt Range Fossils, Palæont. Indica, ser. XIII, vol. I, Productus limestone Foss., p. 272, Pl. XX, fig. 12). To this true representative of the genus *Mytilus* in permian strata a second must be added from the Kuling shales of Spiti. The specimen, which I feel obliged to attribute to this genus, is, unfortunately, fragmentary, consisting only of a single incomplete left valve. But its hinge-line is sufficiently well preserved to preclude identification with *Myalina*, de Kon. The hinge-line is short, not thickened, and without a trace of longitudinal grooves. Immediately below the beak a tooth-shaped prominence is as distinctly developed as in many recent species of *Mytilus*. The terminal position of the beak excluding any identification with *Modiola*, I do not know any other genus but *Mytilus* L., with which the present species could be classed.

This species is probably nearly allied to *Mytilus patriarchalis*, Waag., from the topmost beds of the upper Productus limestone of Chidru, but is of much larger dimensions. It is of triangular shape, with rounded margins, and an acute, anterior and terminal beak. The anterior margin is slightly excavated and sub-parallel to the posterior margin. A sort of indistinct lunula is thus produced in front of the beak, and the shell descends to it in a steeply inclined slope, whereas in general it is but little inflated. The beak is compressed, oblique and attenuated.

The surface is marked with numerous and delicate concentric striæ and with a small number of coarser ridges of growth.

*Locality and geological position: number of specimens examined.*—Kuling shales with *Cyclolobus insignis*, Lilang: 1. (Coll. Krafft.)

### CONOCARDIUM sp. ind. aff. SICULO, Gemm., Pl. VIII, fig. 5.

The permian fossiliferous rocks of Pomarang have yielded one single, fairly well-preserved right valve of a species of *Conocardium*, which appears to be more closely allied to *C. siculum*, Gemmellaro (La fauna dei calcari con Fusulina della Valle del F. Sosio, Fasc. III, Palermo 1895, p. 183, Tav. XX, figs. 21—23), than to any other congeneric form. It agrees with this Sicilian species in the absence of a cordiform anterior area, and in its reticulate ornamentation.

The specimen is of medium size and strongly inflated. It is anteriorly truncate. The rostrum has been broken off almost entirely, but the broken margin indicates its existence. The visceral part of the valve is gibbous, with a strongly curved, only slightly prominent, and prosogyrate beak. The posterior portion is alate and separated from the visceral part by a sharp edge.

The surface is adorned with numerous radiating ribs which are not of equal strength. In the visceral portion of the valve one or two weaker ribs are intercalated between two stronger ones, but the difference in strength is not very conspicuous. In the alate posterior portion of the shell the ribs are of equal strength, but some of them are dichotomous, not simple, as in the visceral part. The radial ornamentation is crossed by a concentric one, which consists of much more delicate lines of growth. The intersection of these two systems of sculpture imparts a faintly reticulate appearance to the surface of the shell.

The measurements of my incomplete specimen are as follows :—

| | |
|---|---|
| Length of the shell (without the rostrum) . . . . . | 15·5 mm. |
| Height of the shell . . . . . . . . . . . | 14 „ |
| Thickness of the right valve . . . . . . . . . | 5 „ |

*Locality and geological position: number of specimens examined.*—Kuling shales south of Pomarang: 1. (Coll. Krafft.)

*Remarks.*—The fragmentary character of the rostrum does not allow the position of this Himalayan species among its congeneric forms to be decided with complete certainty. *Conocardium siculum* appears to be a closely related species, especially from the absence of a cordiform anterior area, by which character it differs from *C. inarmatum* and *C. regulare*, de Kon. Features of distinction between the Sicilian and Himalayan forms are the larger size of the latter and the unequal strength of its radiating ribs.

The presence of this remarkable genus in the permian rocks of the Himalayas is not without interest, since *Conocardium* has not been recorded hitherto from palæozoic strata in India.

### GONIOMYA sp. ind. aff. G. KASANENSIS, Geinitz, Pl. VIII, fig. 11.

From the permian rocks of Russia two species of the family of *Pholadomyacidæ*, Gray, have been described, which in their sculpture agree most nearly with typical forms of the genus *Goniomya*, Agassiz. These species are *Pholodomya kasanensis*, Geinitz (Nachträge zur Dyas, I, 1880, p. 38, Pl. VI, fig. 23), and *Goniomya artiensis*, Krotow (The Antinskian stage, Trudy Soc. of Naturalists, Imper. University of Kasan, T. XIII, pt. 5, p. 255, Pl. III, fig. 20). The appurtenance of these two species to *Goniomya* is advocated by Netschajew (Die Fauna der permischen Ablagerungen des œstlichen Theiles des europäischen Russlands, l. c., T. XXVII, pt. 4, p. 314), who insists on the importance of the peculiar V-shaped sculpture. As features of difference from the typical mesozoic species of *Goniomya* the following are quoted by Netschajew: in typical *Goniomya* the shell is less inequilateral, the apex is approximate to the middle of the dorsal margin, the anterior and posterior margins are compressed, whereas in the two permian species the posterior margin is very broad.

Some uncertainty must naturally prevail, concerning the genus to which those species from the permian rocks of Russia belong, since we are acquainted with fragmentary specimens only. I agree, however, with Netschajew in not attributing to the characters enumerated by him a sufficient importance to remove those species from the genus *Goniomya*. It is more especially to the higher or smaller degree of inequilaterality and the more or less central position of the apex, that I cannot concede the least generic value, those characters being extremely variable in *Goniomya*. I consequently prefer to class both the Russian species, *G. kasanensis* and *G. artiensis*, and two more nearly allied forms from the Productus shales of the Himalayas, with *Goniomya*, although their generic determination is not perhaps altogether free from objection.

One species of *Goniomya* from the permian Productus shales of Kálápáni in Byans has been described in the preceding chapter and has been illustrated on Pl. V, fig. 19, of this memoir. A second species has been discovered in Haydon's and Krafft's collections from the Kuling shales of Kuling in Spiti. My materials of this species consist of an incomplete specimen, with the posterior portion of the right valve broken off, while of the left valve only small fragments have been preserved. These fragments, however, permit the relative position of the two valves to be fixed with certainty, and they clearly show that the species from Spiti differed from that of Byans by its considerably less inflated valves. Another character of distinction is marked by the more numerous V-shaped ribs, the lower angle of which is not situated along a vertical line drawn from the apex to the ventral margin, but is shifted obliquely towards the posterior portion of the shell. In all these characters the present species recalls *G. kasanensis*, Gein. Nevertheless an identification of the Himalayan and Russian species seems to me impossible, the latter being distinguished by the presence of more numerous ribs with their angles shifted still more posteriorly.

Measurements of this specimen cannot be given on account of its fragmentary state of preservation.

*Locality and geological position : number of specimens examined.*—Kuling shales, Kuling : 1. (Coll. Hayden and Krafft.)

### MYOPHORIOPIS (?) KRAFFTI, nov. sp., Pl. VIII, fig. 9.

Among the fossil materials collected in the Kuling shales of Spiti by Dr. A. v. Krafft there is a shell whose affinity lies entirely with the triassic species of the genus *Myophoriopis*, Wöhrmann. The late Dr. Bittner, our greatest authority on the *Lamellibranchiata* of the Alpine Trias declared it to be most nearly allied to this triassic genus. There exist, it is true, some features of difference, as regards the relative dimensions of the two valves, nor can the appurtenance of our Himalayan shell to *Myophoriopis* be established with certainty without any knowledge of its cardinal arrangement. But, on the other hand, I do not like to introduce a new generic designation for a single, incomplete specimen, and I consequently prefer to quote it provisionally as *Myophoriopis* (?).

My specimen consists of both valves, which are attached to each other, but slightly dislocated. The two valves are very markedly inequilateral, the right valve being the larger. The two apices have, unfortunately, been broken off, but from the remaining fragments their strongly prosogyrate character is clearly evident. Below the apices a deeply excavated and cordiform anterior lunula is developed, which causes the lower part of the anterior shell-margin to project considerably in front of the upper.

From the apices in both valves a sharply rounded edge or ridge extends to the posterior end and divides the shell into two portions of very unequal size. This ridge, though very distinctly marked, is not carinate. In the broad posterior area a narrow areola or escutcheon is only indistinctly developed. If present at all, it is reduced to a lanceolate fissure.

The sculpture is very remarkable. It consists of concentric ribs only, but is different in the anterior and posterior portions of the main region in both valves. From the lunula very strong and prominent, acute ribs originate, which gradually diminish in strength towards the apical posterior ridge. In the zone adjoining this ridge the strong and prominent anterior ribs are supplanted by very numerous and delicate, concentric costæ. These costæ cross the apical posterior edge, without interruption, into the posterior area, where they become gradually more delicate.

No trace of any radial sculpture has been noticed.

The measurements of this specimen are as follows :—

| | | |
|---|---|---|
| Entire length of the shell | 31 | mm. |
| „ height of the shell | 33·5 | „ |
| Height of the left valve | ca. 28 | „ |
| Thickness of both valves | „ 19 | „ |

*Locality and geological position: number of specimens examined.*—Kuling shales, nullah opposite Gaichund, right bank of Parahio river: 1. (Coll. Krafft.)

*Remarks.*—This remarkable shell is most nearly allied to the triassic genus *Myophoriopis.*

The genus *Myophoriopis* was introduced by S. von Wöhrmann (Jahrb. K. K. Geol. Reichs-Anst. XXXIX, 1889, p. 221) for a group of triassic shells which, notwithstanding their external affinities with *Myophoria*, are more nearly allied to *Opis*, and must find their proper place, in the geological system, in the family of *Astartidæ*, not of *Trigoniidæ*. Bittner, who merged *Astartopis*, Wöhrm., into *Myophoriopis*, described an isolated species of the genus from St. Cassian as *M. Kittlii* (Lamellibranchiaten der alpinen Trias, Abhandl., K. K. Geol. Reichs-Anst., XVIII Bd., Heft. I, p. 114, Taf. XIII, figs. 11, 12). To this species my Himalayan example shows a closer affinity than to the group of *M. lineata*. Both in *M. Kraffti* and in *M. Kittlii* a deep, cordiform, anterior lunula is present, whereas the posterior areola or escutcheon which is strongly developed in *M. lineata* is reduced to a narrow, lanceolate fissure.

From *Myophoria* the present species is readily distinguished by the presence of a deep, anterior lunula; from *Opis* by the absence of a furrow in front of the apical posterior ridge, from which the shell in *Opis* ascends in a strong elevation, and by the absence of a keel bordering the anterior lunula; from *Astarte* by the presence of a distinctly developed apical-posterior ridge. There is no genus to which it can be more appropriately compared than to *Myophoriopis*. The only feature which makes its appurtenance to the genus *Myophoriopis* somewhat doubtful is its strongly inequivalve shape. All the species of *Myophoriopis* hitherto described are provided with valves of equal or nearly equal size. In the genera of *Astartidæ* the valves are altogether equal or subequal. It is therefore with some doubt that I refer my species from the Kuling shales to *Myophoriopis*, although it agrees with typical representatives of that genus in all other characters accessible to examination.

### MEGALODUS, sp. ind., Pl. VIII, fig. 12.

A fragmentary cast without any trace of shell substance is probably referable to the genus *Megalodus*, Sow.

Should my identification be found to be correct, this species ought to be considered as the first permian representative of *Megalodontidæ* hitherto discovered and as an intermediate link connecting *Megalodus cucullatus*, Goldf., of devonian age, with triassic species of *Megalodus* and its allies. This is the only reason which might justify me in recording the presence of this specimen, which otherwise is absolutely unfit for specific determination.

The internal cast, which exhibits the two valves firmly attached to each other, strongly recalls *Megalodus* in its external shape. The beaks, though almost entirely broken off, appear to have been prosogyrate. A broad anterior lunula is distinctly developed. The hinge-plate must have been very broad and massive, as may be seen by the character of the ridge separating the deep excavations which have been formed by the removal of the weathered shell substance. In this ridge, which is only partly preserved, two impressions are noticed, the posterior and larger corresponding probably to the principal cardinal tooth of the left valve.

The posterior portion of the cast has been entirely broken. It is consequently impossible to state whether or not a posterior myophoric ridge was present.

My cast is of moderately large dimensions, the distance of the two valves measuring 70 mm., and the height of the right valve 75 mm. In the illustration on Plate VIII the original size of the cast has been reduced to two-thirds.

*Locality and geological position: number of specimens examined.*—Kuling shales, Kuling: 1. (Coll. Krafft.)

## GASTEROPODA.

### ENTALIS, sp. ind. (aff. HERCULEA, de Kon.?), Pl. VIII, fig. 18.

A small fragment of a tubular, very elongated, but slightly curved shell is represented in the Himalayan collection. It is not sufficient for a specific determination, but fossil remains of *Dentalidæ* are so rare in strata of upper palæozoic age, that even such an imperfect fragment as the present one deserves notice.

The turreted portion of the shell is very gradually and regularly tapering throughout. The apex has been broken off. The transverse section is circular, and exhibits a shell of considerable thickness, bearing a small tube free only in the middle. The surface is covered with a small number of delicate longitudinal riblets. The striæ of growth are only indistinctly developed. They do not appear to be directly transverse, but somewhat oblique.

The only hitherto known species of *Entalis* from the permian rocks in India is *E. herculea*, L. de Koninck, from the upper Productus limestone of the Salt Range. The description and illustrations of Waagen (Salt Range fossils, Palæont. Indica, ser. XIII, vol. I, Productus Limest. Foss., p. 181, Pl. XVI, figs. 1—3) and of, Enderle (Ueber eine anthracolithische Fauna von Balia Maaden in Kleinasien Beiträge zur Geologie und Palæontologie Oesterreich-Ungarns, etc., XIII Bd., p. 51, Taf. IV, fig. 1) give a very good idea of the characters of this form. Although the possibility that the present fragment corresponds to the apical portion of a tube of

*Entalis herculea* cannot be excluded, this suggestion has but very little probability. We shall be nearer the truth, I imagine, in believing the present species to be different from *E. herculea,* from which it is distinguished by the presence of delicate longitudinal riblets.

*Dentalium Meekianum,* Geinitz (Carbonformation und Dyas in Nebraska, p. 13, Taf. I, fig. 20), from the coal-measures of Nebraska, is distinguished by its more rapidly increasing diameter and by its strongly curved tube.

*Locality and geological position: number of specimens examined.*—Kuling shales, south of Pomarang: 1. (Coll. Krafft.)

## BELLEROPHON cf. VIGILII, Stache, Pl. VIII, figs. 15, 16, 17.

1877. *Bellerophon Vigilii,* Stache. Die Fauna der Bellerophonkalke Suedtirols, Jahrb. K. K. Geol. Reichs-Anst., XXVII Bd., p. 228, Taf. VI, fig. 2.

Numerous casts of a small *Bellerophon* have been obtained from the Kuling shales south of Pomarang by A. v. Krafft. Some slabs of a thick-grained dark limestone or calcareous sandstone, which is intercalated in the black shales, are so full of sections and casts, that they strongly recall the Bellerophon limestone of the South-eastern Alps. All the better preserved specimens belong to a single, carinate species, with a deep slit-band, small body and greatly dilated aperture. It is probably identical with *Bellerophon Vigilii,* Stache, from the permian Bellerophon limestone of Enneberg in Tirol.

In none of my specimens have portions of the shell substance been preserved, nor have I met with a single impression from which information might be gathered concerning the external characters of the surface. It is only the absence of data available in this respect which makes me abstain from a direct identification of my Himalayan with Stache's Alpine species.

The measurements of one of my type-specimens (fig. 16) are as follows:—

| | | |
|---|---|---|
| Diameter of the shell | | 20 mm. |
| " " " umbilicus | | 4 " |
| Breadth of the last volution near the commencement of the aperture | | 14 " |
| Height of the last volution | from the umbilical suture | 11 " |
| | " " preceding whorl | ca. 8 " |

My type-specimens consist of regularly increasing volutions, with a strongly expanded aperture. They are broadly carinate. In one of my examples traces of the slit-band are indicated. The casts are provided with wide and deep umbilici, exhibiting parts of the inner volution. The remarkable similarity of my Himalayan types to the Alpine *Bellerophon Vigilii* is obvious from the illustration of a cast in the Bellerophon limestone of the Enneberg Valley by Stache, which I have figured in Plate VIII, fig. 17, for comparison with the Indian species.

*Locality and geological position: number of specimens examined.*—Kuling shales, south of Pomarang: 10. (Coll. Krafft.)

## BRACHIOPODA.

### CHONETES LISSARENSIS, Diener.

In black shales of the Kuling series near Po (left side of the Spiti river), rock specimens have been collected by Hayden, which are true lumachellæ, being made up almost entirely of casts of *Chonetes lissarensis.* It is probable that besides this leading fossil other species of *Chonetes* are also present, but their state of preservation renders them undeterminable. Most of the casts are fragmentary and strongly weathered, but some examples have been discovered in which the distinctive features of *Chonetes lissarensis* are sufficiently well marked to allow a certain identification.

In the second part of the present volume the presence of *Chonetes lissarensis* has been signalized in Stoliczka's collection from the Kuling shales of Kuling.

### PRODUCTUS cf. GANGETICUS, Diener.

1897. *Productus gangeticus,* Diener. The permian fossils of the Productus shales of Kumaon and Garhwál, Palæontol. Indica, ser. XV, Himalayan Foss., vol. I, pt. 4, p. 28, Pl. I, figs. 1, 2; Pl. II, fig. 3.

A considerable number of fragmentary dorsal valves of a large *Productus* have been collected in the black Kuling shales south of Pomarang by A. v. Krafft. All my specimens are mere fragments of external casts, either of equal length and breadth or transversely oval. In their external characters they are very closely allied to the species described by myself as *Productus gangeticus* from the permian Productus shales of the Niti district. The valves are very flatly convex, with wings slightly excavated and bent up along their margins. A broad median fold is only faintly indicated. The sculpture of the cast, consisting of numerous, regularly arranged, elongated, club-shaped tubercles in the visceral, and of very closely packed longitudinal spines in the marginal, portions of the valve, agrees very well with the ornamentation exhibited in the type-specimens of *Prod. gangeticus* from Painkhánda.

In none of my specimens has the apical region been preserved. I am consequently not able to examine its internal structure, which is one of the leading features of distinction in *P. gangeticus.* My examples are therefore too imperfect to warrant a certain identification, and their direct reference to *Prod. gangeticus* may have elements of doubt, although I know of no other species of *Productus* which could claim closer comparison, especially if the large dimensions of the present specimens are taken into consideration. In one of my fragments a length of about 65 mm. corresponds to a width of about 90 mm. In a second specimen the corresponding measurements are 50 and 74 mm. A similar size is not attained by any *Productus* of the group of *Fimbriati,* with the single exception of *Prod. gangeticus.*

*Locality and geological position: number of specimens examined* —Black Kuling shales, nullah south of Pomarang: 8. (Col. Krafft.)

### MARGINIFERA HIMALAYENSIS, Diener.

Numerous specimens, completely agreeing with those described in the second part of the present volume, have been collected by Hayden and A. v. Krafft in the black Cephalopoda-bearing shales of the Kuling series. The chief localities from which they have been recorded are the following: north-north-west of Kága, 24; north-west of Muth, 22; nullah opposite Gaichund, right bank of Parahio river, 3; north-north-west of Kága, 12; Thanam Valley, 2; Druineh E. G., 11.

### AULOSTEGES cf. GIGAS, Netschajew, Pl. VIII, figs. 13, 14.

1894. *Aulosteges gigas*, Netschajew. The fauna of the permian rocks in the Eastern part of European Russia (in Russian), Trudy Soc. of Naturalists, Imper. University of Kasan, T. XXVII, pt. 4, p. 155, Pl. III, figs. 1, 3; Pl. IV, figs. 3—5, 12.

1900. *Productus Purdoni*, Hayden. General Report, Geol. Surv. of India, 1899-1900, p. 189.

Numerous examples of a large species of one of the *Productidæ* occur in the permian sandstones of Po. The ventral valves strongly recall in their general shape *Productus Purdoni*, Davidson. With this species they have been provisionally identified by Hayden. It was only after a careful preparation of their apical region, that the incorrectness of this identification could be proved by the discovery of a large area with a distinct pseudodeltidium. Thus the appurtenance of our Himalayan form to the genus *Aulosteges*, Helmersen, was ascertained.

There exists a very intimate relationship between my Himalayan specimens and the Russian *Aulosteges gigas*, Netschajew, and I cannot help mentioning that they are only doubtfully distinguishable. If I do not unhesitatingly refer the Himalayan examples from Po to Netschajew's species, it is only on account of the difficulty of a closer comparison of their details of ornamentation, the Russian type-specimens being provided with their shell, which in my Himalayan materials is only fragmentarily preserved. But there is undoubtedly very little probability that *A. gigas* and its Himalayan representatives could be specifically separated.

Among the genus *Aulosteges* there is no other species which in its external shape so strongly recalls *Productus*. Ventral and dorsal valves have never been found attached to each other. The ventral valve is only moderately inflated, and always longer than broad. The hinge-line is shorter than the greatest breadth of the shell, which is situated in the lower or anterior portion of the valve. In the longitudinal direction the apical region is strongly vaulted, but in the visceral region of the valve the curve becomes gradually flattened, and again a little more distinctly arched near the front. In the transverse direction the lateral parts of the valve ascend steeply to the flatly arched and slightly impressed middle part.. In some of my specimens this mesial impression becomes sufficiently broad and distinct to form a true sinus.

The hinge-line is perfectly straight, never arched as in Davidson's type-specimen of *Productus Purdoni*. It is bordered by a broad and flat area, which is covered by numerous and delicate vertical striæ of growth. It is interrupted in the middle by a narrow pseudodeltidium, which is bordered by parallel margins, strongly curved, considerably elevated above the surface of the area and ornamented with a few horizontal marks. The apex projects only very slightly beyond the area, and is barely incurved. In one of my specimens it bears a very distinct, irregularly rounded mark of attachment, looking exactly as if it had been fixed to a foreign body. Otherwise it does not exhibit any traces of malformation.

The majority of my fragments are casts in which fragments of the shelly layer have been only partly preserved. Nevertheless from a combination of the remaining fragments of the shell in my numerous examples we are able to reconstruct the original ornamentation of its surface to a very considerable extent. This ornamentation consists of two elements of sculpture—coarse, closely arranged spines, and irregular concentric wrinkles. In the visceral region the spines are stout and elongated, whereas in the marginal region they are replaced by rounded tubercles, which are more closely clustered together.

Among the concentric wrinkles some are so strongly developed that their marks are not restricted to the shelly layer only, but are visible even on the casts. But their number seems always to be smaller than in Netschajew's Russian type-specimen of *Aulosteges gigas* (l. c., Pl. III, fig. 1). Besides the stronger concentric wrinkles, a very delicate concentric striation is exhibited in those fragments of the shell which have not been injured by weathering. Where the internal cast is perfectly uninjured, it is covered with small, pustular crenulations, but where it has been subjected to weathering, sharp longitudinal grooves appear in their stead. One of my casts is so strongly weathered that the impressions of the cardinal or divaricator muscles are indicated as flat, trapezoidal prominences, covered with deep, strongly marked and very closely arranged furrows.

To Netschajew the dorsal valve of his Russian species was known only in the form of internal casts. Among my Himalayan materials two dorsal valves with their shelly layer almost entirely preserved, have been discovered. In both of them the cardinal region has been broken off. The cardinal process, the remarkable shape of which has been illustrated by Netschajew in Plate IV, fig. 5, of his memoir, is consequently not accessible to examination.

The sculpture of this valve consists of very numerous, closely arranged, elongate and delicate spines, which are replaced by shorter ones in the vicinity of the frontal and lateral margins. Outside the visceral region a few concentric wrinkles can be observed. The surface of the dorsal valve is flatly concave, with a very faint indication of a shallow median fold.

The measurements of my type-specimen are as follows:—

| | | |
|---|---|---|
| Length | of the ventral valve | 61 mm. |
| Breadth | | 52 „ |
| Thickness | | 26 „ |
| Breadth of the area | | 9 „ |
| Length of the hinge-line | | 40 „ |

*Locality and geological position: number of specimens examined.*—Sandstone underlying Kuling shales, north of Po: 11. (Coll. Hayden and Krafft.)

*Remarks.*—Though the present shells, which I consider to belong to ***Aulosteges gigas***, show a very great resemblance to the typical form, as figured by Netschajew, some slight differences might be pointed out, which to me, however, appear to be of too small importance to warrant a specific distinction from the Russian species. This question is, however, not easy to decide, since the differences consist exclusively in the ornamentation, of which character it is difficult to judge in my Himalayan types on account of their state of preservation. So far as their sculpture is known to me, it seems to differ slightly from that of the typical ***A. gigas*** by the smaller number of concentric wrinkles and by the closer arrangement of tubercles or spines. Nevertheless, I prefer to decide in favour of a provisional identification of my Himalayan fossils with Netschajew's species from the permian rocks of Eastern Russia.

### SPIRIGERA GERARDI, Diener, Pl. IX, figs. 6, 7.

This is the commonest leading fossil of the permian sandstones underlying the black Kuling shales, whereas it is rather rare in the shales themselves. The discovery of very numerous examples in all stages of growth has done much towards the elucidation of the range of variability in this species. I refer the reader for information concerning the distinctive characters of the species to the descriptions in my memoirs on the faunæ of the Productus shales of Kumaon and Garhwál (p. 47) and of the anthracolithic system in Kashmir and Spiti (p. 56) and in the foregoing chapter on the fossils from the Productus shales of the Lissar Valley.

The variability, which is well displayed in a considerable number of examples from Spiti, chiefly affects the character of the dorsal valve, which is either with or without a mesial sinus. In typical forms the dorsal valve is very regularly rounded in both directions, and no mesial elevation, nor depression, is developed. This type is illustrated in fig. 6. In this illustration the presence of concentric expansions is clearly exhibited. Besides this typical form a variety with a sinus has been noticed. The sinus is exactly of the same pattern as in the ventral valve, and moderately impressed and bordered by converging margins. It corresponds to a distinct emargination in the front-line.

In a specimen (fig. 7), which belongs to this sinuated variety, some of the internal characters are accessible to observation. In the internal cast of the ventral valve the stout crural plates forming the base of the dental sockets are shown. In front the space left by the dental or rostral plates is marked by the steep slope of the posterior elevation of the socket-walls. The anterior adductor and diductor scars have been slightly obscured by weathering.

*Locality and geological position: number of specimens examined.*—Sandstone underlying the black Kuling shales north of Po, 63 (coll. Hayden and Krafft); north above Thabo, 6 (coll. Krafft); Larsa E. G., Thanam Valley, 3 (coll. Hayden); north-west of Muth, 4 (coll. Krafft); south of Pomarang, 6 (coll. Krafft).

Black Kuling shales, north of Po, 1 (coll. Hayden); south of Pomarang, 3 (coll. Krafft).

### SPIRIGERA cf. PROTEA var. ALATA, Abich, Pl. IX, fig. 5.

1878. *Spirigera protea* var. *alata*, Abich. Geologische Forschungen in den Kaukasischen Ländern I. Th. Eine Bergkalkfauna aus der Araxesenge bei Djulfa in Armenien, p. 56, Taf. VIII, figs. 2, 5, 6; Taf. IX, fig. 10.

1900. *Spirigera protea* var. *alata*, G. v. Arthaber, in Frech u. Arthaber, Ueber das Palæozoicum in Hocharmenien und Persien, Beiträge zur Palæontologie Oesterreich-Ungarns, etc., Bd. XII, Heft 4, p. 275, Taf. XXII, figs. 2, 3.

The existence of this as a Himalayan species depends upon a single specimen, with the apex of the ventral valve broken off, but otherwise very well preserved.

A full description of the numerous varieties of Abich's *Spirigera protea*, one of the most characteristic types of the permian Otoceras beds of Djulfa, will be found in Dr. G. v. Arthaber's memoir. It may be incidentally mentioned that I have been able to compare my example with Arthaber's Armenian type-specimens, to which his illustrations correspond in every respect. My example agrees with them in all characters of importance. The points in which they differ are inconsiderable and barely of specific value; they consist of a stronger development of the varietal characters than is met with in Abich's type.

The present specimen is of triangular shape, strongly inflated, and probably broader than long, so far as we may judge from the dimensions of the smaller valve. The cardinal angles are rounded. The arrangement of furrows or intercostal valleys is exactly the same as in the Armenian examples, but both the furrows and the intermediate elevations are more strongly developed. The sinus in the ventral valve is very deeply impressed and regularly rounded at the bottom. The two valleys, which border the high and narrowly rounded folds on each side of the mesial sinus, can be traced into the vicinity of the apical region. The same remark applies to the deep furrows in the dorsal valve, which separate the two lateral elevations from the mesial fold. The top of the latter is not so broadly flattened as in the Armenian examples; a mesial furrow along its crest is consequently only quite indistinctly developed. Thus a developmental series of varieties can be traced from *Spirigera protea* var. *quadrilobata* to the present specimen, which is characterized by a gradual decrease in the development of a mesial furrow along the top of the dorsal fold.

Although the shell has been partly preserved, I have not succeeded in discovering any traces of a radial ornamentation. Striæ of growth, however, are rather strongly developed, especially along the two mesial folds of the ventral valve, where they are not confined to the vicinity of the front.

The measurements of the present specimen are as follows :—

| | |
|---|---|
| Length of the dorsal valve . . . . . . . . | 16 mm. |
| Breadth of the dorsal valve . . . . . . . . | 19·5 ,, |
| Thickness of both valves . . . . . . . . | 15 ,, |

*Locality and geological position ; number of specimens examined.*—Black Kuling shales, north-west of Muth : 1. (Coll. Krafft.)

*Remarks.*—There can be no doubt that this specimen belongs to Abich's group of *Spirigera protea*. A satisfactory diagnosis of this remarkable group has been given by G. v. Arthaber. Its distinctive features are: the presence of median furrows in both valves, especially in the ventral, which are bordered by strong folds; the development of secondary lateral folds and corresponding furrows; the peculiar shape of the frontal wave, which shows a large median saddle of either high and rounded or low and angular outlines, bordered on each side by a deeper or principal and by a smaller, secondary lobe. In this diagnosis all the important characters of my Himalayan specimen are included. But I must go a step further and suggest that the Himalayan *Spirigera protea* is probably identical with Abich's *var. alata*, although some difference is shown in the details of their features. Some palæontologists may probably deny the identity of the two shells and may prefer to retain a special varietal denomination for the Himalayan form. But as the general character is the same in both, and as the differences consist in a stronger development, or accentuation, of the distinctive features of the *var. alata*, I have come to the conclusion that the term *alata* might advantageously be made use of for the Himalayan species.

### SPIRIFER RAJAH, Salter.

I can add but very little to what has been stated in my memoir on the anthracolithic fossils of Kashmir and Spiti and in the third chapter of this monograph.

The species is very numerously represented in Hayden's and Krafft's collections from the Kuling shales. Several examples have been met with at Lilang in the same slabs of rock from which specimens of *Cyclolobus* were extracted. The species seems to be entirely restricted to these shales, which form the uppermost portion of the Kuling series in Spiti. No specimens are recorded, either from the underlying permian sandstone or from the Fenestella beds and the grey flaggy limestone of Muth with *Spirifer Curzoni*.

The most characteristic feature in the sculpture of *Spirifer rajah* is the presence of coarse, broadly vaulted, primary ribs, each of which is ornamented by a variable number of lower, secondary costæ. In one of my specimens from Kága the primary ribs are less prominent than in the generality of examples. Although each of them corresponds to a bundle of secondary costæ, the intermediate valleys are only slightly more strongly developed than the furrows separating the secondary ribs. Thus an ornamentation is produced which somewhat recalls that of *Sp. Fritschii*, Schellwien (Palæontographica, 39 Bd., 1892, p. 43, Taf. V, figs. 4—8, Abhandl. K. K. Geol. Reichs-Anst., XVI Bd., p. 71, Taf. X, figs. 7—10). Nevertheless the difference, especially in the shape of the sinus, is sufficiently well marked to exclude any possibility of confounding the two species, which in their typical forms are very far distant from each other.

*Locality and geological position: number of specimens examined.*—Black Kuling shales, Lilang, together with *Cyclolobus Kraffti*, Dien., 3 (coll. Krafft);

seven miles north-north-west of Kága, 7 (coll. Hayden); Thanam Valley, 3 (coll. Hayden); Kuling, 1 (coll. Krafft); north-north-west of Kága, 4 (coll. Hayden); north-north-west of Muth, 22 (coll. Krafft); south-east of Muth, 2 (coll. Hayden); nullah opposite Gaichund, right bank of Parahio river, 3 (coll. Krafft).

### SPIRIFER MARCOUI, Waagen, Pl. VII, fig. 1.

1858. *Spirifer striatus*, Marcou. Geology of North America, p. 49, Pl. VII, fig. 2.
1888. *Spirifer Marcoui*, Waagen. Salt Range Fossils, Palæontologia Indica, ser. XIII, vol. I, Productus Limestone Foss., p. 510, Pl. XLVII.

Two large and partly weathered, but almost complete, examples of this characteristic and easily recognised species have been met with. They are not inferior in size to the largest specimens collected by Waagen in the Productus limestone of the Salt Range. Their most conspicuous peculiarity is the deep sinus of the ventral valve and the corresponding high and crest-shaped mesial fold in the dorsal valve. The mesial sinus is sharply impressed in the middle and limited on both sides by obtusely rounded ridges. In the figured specimen the area is comparatively low, whereas it is nearly twice as high in my second example. But in both specimens it is straight, not concave as in *Spirifer Ravana*, Diener.

While describing *Sp. Ravana* in the fourth part of the present volume (p. 34), I did not omit to refer to the several difficulties in the way of a satisfactory determination of this species. It is so nearly allied to *Sp. Marcoui* that I considered it only a matter of taste whether the differences between them should be admitted or should not as sufficient for the distinction of two separate species. As distinguishing features the following have been enumerated: the concave shape of the area, and the presence of broad, shallow ridges or folds, following the direction of the striæ in *Sp. Ravana*. My examination of two true representatives of Waagen's *Sp. Marcoui* has convinced me of the correctness of this statement. Whereas the breadth of the area is a variable feature, its shape appears to be a character of greater importance, my two examples of *Sp. Marcoui* from Spiti differing in this respect from my type-specimen of *Sp. Ravana* from the Productus shales of Kiunglung E. G. Nor is any trace of folds or ridges observable in the present specimens of *Sp. Marcoui*. Their surface is covered with numerous and delicate radiating striæ. In the dorsal valve of the figured specimen a tendency to form bundles or fasciculi is rather indistinctly developed, whereas fasciculi are entirely absent in the ventral valve. But such fasciculi of radiating lines are different from the shallow folds in *Sp. Ravana*, which in the latter species do not correspond to separate bundles of striæ.

It cannot, however, be denied that these distinctive features are of so little value that the name *Sp. Ravana* might perhaps be used better as a varietal than as a specific denomination.

In the dorsal valve of the figured specimen the radiating lines are crossed by imbricating, irregular marks of growth.

The measurements of the figured specimen are as follows :—

| | |
|---|---|
| Entire length of the shell | 66 mm. |
| „ breadth „ „ | 94 „ |
| Length of the dorsal valve | 57 „ |
| Thickness of both valves | 54 „ |
| Breadth of the area of the ventral valve | 9 „ |

*Locality and geological position : number of specimens examined.*—Sandstone underlying Kuling shales, north of Po : 2. (Coll. Hayden and Krafft.)

*Remarks.—Spirifer Marcoui* is quoted from the Amb beds (lower Productus limestone) and from the base of the middle Productus limestone by Waagen. According to Noetling it is one of the leading fossils of the Amb beds.

Prof. Waagen quotes Marcou's *Sp. striatus* as a synonym of *Sp. Marcoui.* Marcou's type-specimen was found at Pecos village (New Mexico) in a bed of limestone, which probably forms part of the coal-measures.

### SPIRIFER FASCIGER, Keyserling (= SPIRIFER MUSAKHEYLENSIS, Davidson).

Very large examples of this species have been recently found by Mr. Hayden in the black shales of the Kuling series in Spiti. A fairly complete ventral valve from Kága measures 52 mm. in length and 120 mm. in width. A dorsal valve from the same locality measures 54 mm. in length and probably more than twice as much in breadth.

To the detailed descriptions which have been given in Part 4 (p. 35) and Part 2 (p. 63) of the present volume, I have but little to add. The variability of the shapes is, however, even greater than I had formerly supposed. Among the large Himalayan materials entrusted to me for examination no specimen had hitherto been found agreeing completely with Tschernyschew's and Gruenewaldt's type-specimens of *Spirifer fasciger* in the character of the folds. Now in the sandstones underlying the black Kuling shales of Kága a dorsal valve has been discovered by Hayden, in which the folds corresponding to the fasciculi of ribs are not rounded, as in the generality of Indian types, but provided with acute edges. That *Sp. fasciger* and *Sp. nitiensis* are linked together by a series of intermediate shapes, will be explained more fully in the following description of the latter species.

*Locality and geologial position : number of specimens examined.*—Sandstones underlying black Kuling shales, north of Po, 10 (coll. Hayden and Krafft) ; north above Thabo, 3 (coll. Krafft).

Black Kuling shales, north-north-west of Kága, 3 (coll. Hayden) ; Lilang, 1 (coll. Krafft) ; north above Thabo, 3 (coll. Krafft).

### SPIRIFER NITIENSIS, Diener.

In my memoir on the anthracolithic fossils of Kashmir and Spiti (p. 65) I signalized the presence of this species in the sandstones associated with the black Productus or Kuling shales near Po in Spiti. At the same locality a large number of examples has been recently collected by Hayden and Krafft.

It is a rather astonishing fact that among these specimens single ventral valves by far predominate, whereas dorsal valves are extremely rare.

The most conspicuous character of this species is its strongly transverse, often fusiform shape. Typical forms are very easily distinguished from *Spirifer fasciger* by their remarkable width and peculiar ornamentation. The latter is characterized by very numerous fasciculi of ribs, each of them consisting of a small number (three to four) of single costæ of unequal strength. But in a considerable number of specimens the ribs composing the different fasciculi become either indistinct or nearly equal in strength. The central rib, which in typical shapes is the most prominent, gradually diminishes in size from the fasciculi bordering the mesial sinus, towards the attenuated wings which are only very delicately plicated. Thus true transitional forms between *Sp. nitiensis* and *Sp. fasciger* may occasionally be found in which the larger number of fasciculi remains the only uncertain feature of distinction. If the ornamentation has been obliterated by weathering, a determination of fragmentary specimens may become difficult, but in well-preserved examples one rarely finds any difficulty in keeping the two species separate.

By gradual obliteration of the secondary ribs exceptional shapes of *Sp. nitiensis* approach rather closely to some types of the permian *Sp. alatus*, Schloth. But the true *Sp. alatus* remains always comparatively small and its ribs are less broad than the folds, which in *Sp. nitiensis* result from a coalescence of three or four indistinct secondary costæ.

The species attains very large dimensions. In the permian sandstone north of Po a ventral valve has been collected by A. v. Krafft and Hayden measuring 42 mm. in length and about 130 mm. in width.

*Locality and geological position: number of specimens examined.*—Sandstones underlying black Kuling shales, north of Po, 18 (coll. Hayden and Krafft); north-north-east of Po, 1 (coll. Hayden); south of Pomarang, 1 (coll. Krafft).

### SPIRIFER DISTEFANII, Gemmellaro, Pl. IX, figs. 2, 3, 4.

1899. *Spirifer Distefanii*, Gemmellaro. La fauna dei calcari con Fusulina della Valle del F. Sosio, Fasc. IV, pte. I, p. 300, Pl. XXXVI, figs. 18—26.

This species, as introduced by Gemmellaro, contains forms which in their general shape recall the group of *Spirifer pinguis*, Sow., with smooth sinus and dorsal fold, and with very delicately ornamented lateral parts. Among Krafft's and Hayden's Himalayan collection it is represented by a large number of examples. Though nearly all of them are fragmentary, an examination of several specimens is sufficient to afford a clear idea of the characters of the species.

The majority of my specimens are smaller than Gemmellaro's type-specimens from the Sosio limestone of Sicily, and only one attains the dimensions of his largest type-specimen (figs. 21—24). Suborbicular shapes, recalling Gemmellaro's illustration in figs. 19 and 20, are an exception. Transversely elongate shapes largely predominate, and some exceptional shapes (fig. 4) are nearly twice as wide as long. The hinge-line is always considerably shorter than the greatest width of the shell, and provided with rounded cardinal angles. The greatest transverse diameter is situated a little anteriorly to the middle of the length.

Another character, which is subject to some variation, is the convexity of the valves. Thus size, gibbosity and proportional width are as variable in the present species as in any belonging to the genus *Spirifer*. But, in accordance with Prof. Davidson, I am convinced that these characters cannot be considered as of specific importance in the group of *Sp. pinguis*, since they vary in almost every individual, and since every link may be traced connecting the most extreme variations represented by either form.

The illustrations which I have selected for Plate IX do not prove conclusively the intimate affinity between the different shapes, but my opinion as to their specific identity has been founded upon the examination of forty individuals.

In all their characters, excepting those of size, gibbosity and proportional width, my specimens are identical. The ventral valve, which, as a rule, is a little more convex than the opposite one, is provided with a smooth median sinus, which originates at the apex as a narrow sulcus, bordered by sharp margins, and widens out considerably towards the front. It is always distinctly defined and either rounded or flatly depressed at the base. In none of my specimens is there any trace of ornamentation within the sinus, which either is, or is not, produced into a tongue-shaped process at the front.

In the dorsal fold a broad mesial elevation or fold corresponds to the smooth, strongly diverging sinus of the opposite valve. This fold is always marked off from the remainder of the shell by distinct furrows, and is, as a rule, flattened or only slightly convex along its top. In specimens provided with a tongue-shaped process at the front of the ventral valve the fold becomes very prominent anteriorly. It is either smooth or interrupted by a delicate median groove or furrow.

In both valves the lateral parts are ornamented with a variable number of ribs, which are never very strongly developed, but in some examples become so delicate, that they are only noticed if looked at under special conditions of light. They are always more distinctly developed in the dorsal valves.

Where the surface of the shell has been preserved, concentric striæ of growth can be seen intersecting the radial plications.

The beak of the ventral valve is small, prominent and pointed. The hinge-line is bordered by a low and narrow area. In the generality of Himalayan examples it is even lower than in Gemmellaro's type-specimens.

The relative proportions vary considerably, as will be perceived from the measurements taken from three fairly complete individuals.

| | I. | II. | III. |
|---|---|---|---|
| Entire length of the shell . . . | 21 mm. | 23·5 mm. | 21 mm. |
| „ breadth „ „ . . . | 33 „ | 27 „ | 25 „ |
| Length of the dorsal valve . . . | 18 „ | 21 „ | 18·5 „ |
| „ „ hinge-line . . . | 26 „ | 19 „ | 17 „ |
| Thickness of both valves . . . | 15 „ | 18 „ | 13·5 „ |

*Locality and geological position: number of specimens examined.*—Sandstones underlying black Kuling shales, 4 miles west of Po, 24 (coll. Krafft); north of Po, 13 (coll. Hayden and Krafft); north above Thabo, 2 (coll. Krafft); half-way between Po and Máni, left bank of Spiti river, above Dankhar road, 2 (coll. Hayden).

### STREPTORHYNCHUS cf. PECTINIFORMIS, Davids., Pl. IX, fig. 8.

1862. *Streptorhynchus pectiniformis*, Davidson. On some carboniferous Brachiopoda, collected in India by A. Fleming and W. Purdon, Quart. Journ., Geol. Soc., London, vol. XVIII, p. 30, Pl. I, fig. 17.

1863. *Streptorhynchus pectiniformis*, Davidson, in L. de Koninck, Memoir des fossiles paléozoiques recueillis dans l'Inde. p. 37, Pl. X, fig. 17.

1864. *Streptorhynchus pectiniformis*, Waagen. Salt Range Fossils, Palæontologia Indica, ser. XIII, vol. I, Productus Limestone Fossils, p. 587, Pl. LV, figs. 4—11.

Most of the specimens by which the sub-family of *Orthothetinæ* is represented in Hayden's and Krafft's collections are specifically undeterminable. One example only, consisting of a single ventral valve, may be provisionally identified with *Streptorhynchus pectiniformis*, Dav. Everyone who is acquainted with the difficulty of determining shells belonging to a genus of the *Orthothetinæ* will understand the reasons which induce me to consider this identification far from being safe, although the external characters of my example speak rather strongly in its favour.

The ventral valve is of triangular, semiconical shape, and little inflated. The latter character is contradictory to Waagen's diagnosis, who describes the ventral valve of *St. pectiniformis* as strongly inflated and equally curved in the longitudinal and transverse directions. But some of Waagen's illustrations (l. c., Pl. LV, figs. 5, 7) clearly show that very moderately inflated examples occur together with more gibbous ones.

The apex is greatly attenuated but its pointed beak is not accessible to examination, having been broken off. The front-margin has not been preserved. The hinge-line is considerably shorter than the greatest breadth of the shell. It is bordered by an area, which is broader than high, slightly concave and interrupted in the middle by a narrow, convex pseudodeltidium.

The sculpture agrees entirely with that of the Salt Range specimens of *St. pectiniformis*. It consists of radial striæ, which originate in the apex and cover the entire surface of the valve, and of irregular, radiating plications, which occur to the number of ten or eleven in the visceral and marginal regions of the shell. The striation remains approximately parallel to the coarse plications, but occasionally converges irregularly towards the top of the latter.

It is chiefly this remarkable ornamentation on which my identification of the Himalayan specimen with *St. pectiniformis* is founded. A similar sculpture is exhibited in *Meekella striatocostata*, Cox, of which satisfactory illustrations have been given by Geinitz (Carbonformation und Dyas in Nebraska, 1866, Taf. III, figs. 22—24) and by Meek (Palæontology of Eastern Nebraska; Meek and Hayden, Final Report of the U. S. Geol. Surv. of Nebraska, Pl. V, fig. 12). But the American examples figured by these authors are sub-globose, becoming very convex with age, although a generic difference between ***Streptorhynchus pectiniformis*** and ***Meekella striatocostata*** is only revealed by their internal characters. With regard to the latter I can only say that in my Himalayan specimen no traces of dental plates are observable in the apical region. This fact tends to confirm the correctness of placing the Himalayan species among the genus ***Streptorhynchus***, not among ***Meekella***, but I must hasten to add that my statement is based on an external examination of the apical region of my specimen only, not of a transverse section, which could not be made without destroying the specimen. Thus the identification with ***St. pectiniformis*** cannot be considered as perfectly safe.

The present valve is provided with a small number of strongly marked ridges of growth, which form very indistinct zig-zag lines, recalling in this respect the irregular ridges in the Punjab specimen illustrated in fig. 7 of Waagen's memoir, rather than Davidson's type-specimen.

*Locality and geological position: number of specimens examined.*—Sandstone underlying black Kuling shales, north of Po: 1. (Coll. Krafft and Hayden.)

*Remarks on the species of Orthothetinæ represented in Hayden's and Krafft's Himalayan collections.*—A small number of ventral and dorsal valves from the permian sandstone of Po recall the group of *Derbyia senilis*, Phill. *D. grandis*, Waagen, and *D. regularis*, Waagen, might be compared with them, but the fragmentary character of the apical portion in the ventral valves excludes the possibility of a generic determination. Thus I must be satisfied with recording the presence of species belonging to the sub-family of *Orthothetinæ* in the permian rocks of Spiti.

### DIELASMA LA TOUCHEI, Diener.

Specimens of this interesting species, a full description of which has been given in the notes on the fauna of the Productus shales of the Lissar Valley, have been discovered in the permian sandstones underlying the black shales of the Kuling series; near Thabo 3 were collected by A. v. Krafft, and north of Po 8, by Krafft and Hayden.

## VI.—CORRELATION OF THE ANTHRACOLITHIC SYSTEM IN SPITI WITH THE CARBONIFEROUS AND PERMIAN SYSTEMS IN EUROPE AND INDIA.

Wherever in Spiti a complete series of the anthracolithic system is developed and well exposed, *two groups* can be recognised and distinguished, as has been stated by Hayden. Both groups are separated by a great *unconformity*, and differ remarkably in their faunistic character and in their lithological features.

The group above the great unconformity, which corresponds to the Productus shales of the Niti area, is much better known than the lower division, because richer collections of fossils have been examined. The sequence of beds has been carefully studied by Hayden and A. v. Krafft. According to their observations the series above the great unconformity can again be divided into three sub-divisions, in descending order—

C. Black shales with limestone partings.
B. Calcareous sandstones.
A. Unfossiliferous grits and conglomerates.

In 1901 Noetling (Beiträge zur Geologie der Salt Range, insbesondere der permischen und triassischen Ablagerungen, Neues Jahrb. f. Min., etc., Beilageband XIV, p. 443) compared these rock-groups with the Productus limestone formation of the Salt Range. He correlates the black Kuling shales (C) with the upper Productus limestone or Chidru group, the calcareous sandstone (B) with the middle Productus limestone (Virgal group), but leaves the question undecided as to whether the underlying grits and conglomerates ought to be considered as equivalents of the Warcha and Amb group or only of the Amb beds.

The results of my examination of the fossils collected in the black Kuling shales and in the underlying calcareous sandstones by Hayden and Krafft are entirely in accordance with Noetling's correlation.

The correlation of the basal grits and conglomerates cannot be based on palæontological evidence, no fossils from this rock-group being represented among the Himalayan collections. But the two following divisions contain numerous remains of marine animals of a decidedly permian age.

The following is the list of fossils described from the black Kuling shales with limestone partings, which form the topmost group of the permian system in Spiti and pass gradually into the lowest beds of triassic age (zones of ***Otoceras Woodwardi***, Griesb., and ***Meekoceras Noetlingi***, Krafft) :—

*Cephalopoda.*

*Orthoceras*, sp. ind.
*Nautilus* (*Grypoceras*), sp. ind.
*Xenaspis* cf. *carbonaria*, Waag.
*Cyclolobus* cf. *Oldhami*, Waag.

*Cyclolobus insignis*, nov. sp.
,, (*Krafftoceras*) *Kraffti*, nov. sp.
,, *Haydeni*, nov. sp.

### *Lamellibranchiata.*

*Modiolopsis Teplofi*, Vern.
*Solemya biarmica*, Vern.
*Mytilus*, sp. ind.
*Conocardium* sp. ind. aff. *siculo*, Gemm.
*Oxytoma laticostatum*, Netsch.
*Goniomya* sp. ind. aff. *Kasanensis*, Gemm.
*Myophoriopis Kraffti*, nov. sp.
*Megalodus*, sp. ind.

### *Gasteropoda.*

*Entalis*, sp. ind.
*Bellerophon* cf. *Vigilii*, Stache.

### *Brachiopoda.*

*Productus* cf. *gangeticus*, Dien.
*Marginifera himalayensis*, Dien.
*Chonetes lissarensis*, Dien.
*Spirifer rajah*, Salter.
,, *fasciger*, Keyserl.
*Spirigera* cf. *protea* var. *alata*, Abich.
,, *Gerardi*, Dien.

These fossils are, however, not generally distributed throughout the Kuling shales, but appear rather to be confined to certain localities only. In the following list the fossils of this horizon have been enumerated with respect to the localities where they have been collected.

### *S. of Pomarang.*

*Oxytoma laticostatum*, Netsch.
*Modiolopsis Teplofi*, Vern.
*Solemya* cf. *biarmica*, Vern.
*Conocardium* sp. ind. aff. *siculo*, Gemm.
*Entalis*, sp. ind.
*Bellerophon* cf. *Vigilii*, Stache.
*Productus* cf. *gangeticus*, Dien.
*Spirigera Gerardi*, Dien.

### *N.-W. of Muth.*

*Orthoceras*, sp. ind.
*Spirigera* cf. *protea* var. *alata*, Abich.
*Spirifer rajah*, Salt.
*Marginifera himalayensis*, Dien.

### *Danksá E. G.*

*Xenaspis* cf. *carbonaria*, Waag.

### *N.-N.-W. of Kdga.*

*Cyclolobus* cf. *Oldhami*, Waag.
*Spirifer rajah*, Salt.
„ *fasciger*, Keyserl.
*Marginifera himalayensis*, Dien.

### *Nullah opposite Gaichund.*

*Myophoriopis Kraffti*, nov. sp.
*Spirifer rajah*, Salt.
*Marginifera himalayensis*, Dien.

### *Lilang.*

*Cyclolobus insignis*, nov. sp.
„ *Haydeni*, nov. sp.
„ *Kraffti*, nov. sp.
*Mytilus*, sp. ind.
*Spirifer rajah*, Salt.
„ *fasciger*, Keyserl.

### *Kuling.*

*Cyclolobus Haydeni*, nov. sp.
*Goniomya* sp. ind. aff. *kasanensis*, Gemm.
*Megalodus*, sp. ind.
*Marginifera himalayensis*, Dien.
*Spirifer rajah*, Salt.

### *Vicinity of Po.*

*Cyclolobus Haydeni*, nov. sp.
*Nautilus* (*Grypoceras*), sp. ind.
*Chonetes lissarensis*, Dien.
*Spirigera Gerardi*, Dien.

Only two species, which must be considered as the commonest leading fossils of this horizon—*Marginifera himalayensis*, Dien., and *Spirifer rajah*, Salt.—are of a geographically wide and equal distribution throughout the permian Kuling shales of Spiti.

The fossils to which the greatest stratigraphical importance must be attributed are the ammonites of the two genera *Cyclolobus* and *Xenaspis*. The presence of a species which is most nearly allied if not actually identical with *Cyclolobus Oldhami*, Waag., and the frequent occurrence of representatives of the genus *Cyclolobus*, speak very strongly in favour of a correlation with the upper Productus limestone of the Salt Range. In the Salt Range *Xenaspis carbonaria* is, according to Noetling, restricted to one single horizon only, namely, to the top beds of the middle Productus limestone.

Whether it is the true *Xenaspis carbonaria* which has been discovered in the Kuling shales of Danksá E. G. by Hayden, or only a very nearly allied species, cannot be ascertained. Its presence in the Kuling shales of Danksá is in no sense adverse to a correlation of the main mass of the Kuling shales with the upper Productus limestone. The species has not been found together with *Cyclolobus*, but may indicate that the zone of *X. carbonaria* is probably included in the fauna of the Kuling shales of Spiti, which in general are homotaxial to the upper Productus limestone or Chidru group of the Salt Range. This is Noetling's view, with which I fully agree, considering new researches concerning the distribution of *X. carbonaria* in the Kuling shales as necessary for settling the question.

A bed of peculiar interest is the limestone which south of Pomarang is intercalated in the dark, micaceous Kuling shales. It is rich in gasteropods and bivalves, and recalls the Bellerophon limestone of the South-Eastern Alps. With the fauna of this remarkable horizon it has probably one species—*Bellerophon Vigilii*, Stache—in common. The predominance of European permian types in this limestone is an interesting fact. Three species of bivalves—*Modiolopsis Teplofi, Solemya biarmica, Oxytoma laticostatum*—are identical with such from the permian strata of Russia, whereas another one is most nearly allied to *Conocardium siculum* from the permian Fusulina limestone of Sosio in Sicily.

As faunistic elements of special interest in the Kuling shales of Spiti, *Grypoceras* sp. ind., *Myophoriopis Krafft*i and *Spirigera* cf. *protea* var. *alata* may be quoted. The first and second are remarkable for their decidedly triassic affinities, the third belongs to a group of forms which has hitherto been recorded only from the permian rocks of Djulfa.

The calcareous sandstone underlying the black Kuling shales has yielded numerous fossils in the sections of Po, Muth, Thabo and south of Pomarang. The fauna is, however, rather poor in species, though very rich in individuals. The following is the list of fossils described from this horizon:—

### *Lamellibranchiata.*

*Oxytoma laticostatum*, Netsch.
*Aviculopecten*, sp. ind.

### *Brachiopoda.*

*Aulosteges* cf. *gigas*, Netsch.
*Spirifer fasciger*, Keyserl.
,, *nitiensis*, Dien.
,, *Distefanii*, Gemm.
,, *Marcoui*, Waag.
*Spirigera Gerardi*, Dien.
*Streptorhynchus* cf. *pectiniformis*, Dav.
*Derbyia* (?). pl. sp. ind.
*Dielasma La Touchei*, Dien.

Three species—*Oxytoma laticostatum*, Netsch., *Spirifer fasciger*, Keys., *Spirigera Gerardi*, Dien.—are also known from the black Kuling shales.

With the Productus limestone of the Salt Range this horizon has three species in common: *Spirifer fasciger*, *Sp. Marcoui* and *Streptorhynchus* cf. *pectiniformis*. The first species ranges throughout the entire Productus limestone series, the second has been quoted from the Amb beds and from the Lower Division of the middle Productus limestone by Waagen, the third from the middle and upper Productus limestone.

An affinity to the permian faunæ of Europe is indicated by three identical species: *Oxytoma laticostatum*, *Aulosteges gigas* and *Spirifer Distefanii*.

Although no very close relations seem to exist between the fauna of this horizon and that of the Salt Range Productus limestone, the present fauna, judging from its general geological character and from the intimate stratigraphical connection of the Kuling shales with the underlying calcareous sandstones, can only be looked upon as an equivalent of the Virgal group or middle Productus limestone, as has been suggested by Noetling.

Griesbach correlated the Kuling shales of Spiti with the permian Productus shales of Johár and Painkhánda. This correlation, which was chiefly based on stratigraphical and lithological characters, has been fully confirmed by palæontological evidence. The following species of the Productus shales of the Niti district, the Lissar Valley and Byáns are identical with forms from the black Kuling shales and from the underlying calcareous sandstone in Spiti :—

*Chonetes lissarensis*, Dien.
*Productus gangeticus*, Dien.
*Marginifera himalayensis*, Dien.
*Spirifer rajah*, Salt.
" *fasciger*, Keyserl.
" *nitiensis*, Dien.
*Spirigera Gerardi*, Dien.
*Dielasma La Touchei*, Dien.

The majority of these species are restricted exclusively to the permian rocks of the Himalayas, and do not occur in any other areas.

Both the black Kuling shales and the underlying calcareous sandstones of Spiti are included in the Productus shales of the eastern districts of the Central Himalayas, where the thickness of the permian system has been considerably reduced. Rock specimens which are lithologically similar to the calcareous sandstone of the Kuling series in Spiti have been noticed in Griesbach's collections from Kiunglung E. G., but from his description[1] it is evident that no distinct horizon of sandstones is developed at the base of the black Productus shales in the Niti area, but that "the thickness of the shales is divided by a few irregular partings of sandstone only." The correlation of the Productus shales of Johár and Painkhánda with the Salt Range Productus limestone can be fixed more accurately now than had hitherto been possible. The Productus shales of Kumaon and Garhwál are homotaxial with the middle and upper Productus limestone, and must consequently be considered as equivalents of the European Zechstein, as has been demonstrated by Noetling.[1]

---

[1] Geology of the Central Himalayas, Mem. Geol. Survey of India, XXIII, 1891, p. 66.

The fact that the Productus shales overlie the white carboniferous quartzite of the Niti district with unconformity, and that no equivalents of the grits and conglomerates at the base of the permian calcareous sandstone of Spiti have been noticed in the section of Kiunglung by Griesbach, seems to be of some importance. It might possibly prove that the deposit of beds has been interrupted for a longer time in the Niti area than in Spiti, and that no equivalents of the Amb beds are represented in the Productus shales of Kumaon and Garhwál. Further stratigraphical observations are, however, required to confirm this view.

Our knowledge is much more scanty with regard to the lower series of the anthracolithic system in Spiti, which is situated below the great unconformity.

According to Hayden, the total thickness of this series is not less than 5,000 feet in the section above Lio on the Lipak river, where the sequence of beds is most complete. Two fossiliferous horizons only have been discovered in this mighty sequence. The examination of the fossils collected by Hayden and Krafft, on which the stratigraphical conclusions of these two authors are based, speak in favour of an *upper carboniferous* age.

The upper horizon—Hayden's Fenestella beds—from which fossils have been collected in the sections of Po and of the Losar Nullah, has yielded the following fossils:

*Cephalopoda.*

*Orthoceras*, sp. ind.

*Lamellibranchiata.*

*Aviculopecten* sp. ind. aff. *A. hiemalis*, Salt.
" " " aff. *A. morahensis*, Waag.
*Myalina* sp. ind. aff. *M. recurvirostris*, Meek et Worth.
*Posidonomya*, sp. ind.

*Brachiopoda.*

*Productus undatus*, Defr.
" *scabriculus*, Mart.
" " nov. var. *spitiensis*.
" *Nystianus* var. *lopingensis*, Keys.
*Camarophoria*, nov. sp. (aff. *acuminata*, Gemm).

---

[1] While fully accepting Noetling's conclusions concerning the correlation of the Kuling series and Productus shales of the Himalayas, I must refute the statement made by him when criticising the view previously taken by me in this matter. Noetling writes (l. c. p. 445) that "Diener is disposed to consider the Productus shales as equivalents of the *entire* permian system," and he quotes my memoir (pt. 4 of the present volume, p. 53) as a proof of this statement. But to this I feel obliged to reply that no reference to a similar correlation will be found in that memoir. It is probably my attempt to avoid any direct correlation of the fauna of the Productus shales with permocarboniferous and permian faunæ of Europe and India which gave rise to such a misunderstanding. In reality I came to the conclusion that palæontological evidence did not appear sufficient for any direct correlation, which must be based on stratigraphical evidence only, namely, "on the stratigraphical connection of the Productus shales with the triassic, and on their unconformity to the carboniferous series."

### *Bryozoa.*

*Fenestella* sp. ind. aff. *plebeia*, M'Coy.
*Protoretepora ampla*, Lonsd.

Hayden had already recognised the strong affinities of the fauna of the Fenestella shales of Spiti to that of the Zewán or Barus beds of Kashmir. So far as the small number of fossils available for comparison permits a direct correlation, the homotaxis of the Zewán and Fenestella beds appears indeed to be the most plausible. The lithological character is the same in both rock groups. The faunistic element, which is by far the richest in individuals, namely the *Bryozoa*, is represented by identical species, among which *Protoretepora ampla* is a very remarkable type, thus proving unmistakably the faunistic relationship with the Zewán beds. Of Brachiopoda three species—*Productus undatus*, *Prod. scabriculus* and an undetermined species of *Camarophoria*—are identical. The presence of *Prod. nystianus* var. *lopingensis* also gives this fauna a decidedly upper carboniferous aspect.

This list of species is a rather meagre one, but its value is greatly strengthened by the absence of any type which has hitherto been met with only in strata of lower carboniferous age.

The lower of the two fossiliferous horizons in the anthracolithic series below the great unconformity is the grey flaggy limestone north-west of Muth (8*a*, Griesbach). It has yielded only the following species of Brachiopoda :—

*Productus lineatus*, Waag.
  „ sp. ind. (group of *semireticulati*).
*Derbyia* cf. *senilis*, Phill.
*Spirigera* cf. *Roysii*, Lév.
*Spirifer Cursoni*, nov. sp.
  „ sp. ind. aff., *S. Cursoni*.
  „ cf. *Strangwaysi*, Vern.
*Spirifer* (*Ambocœlia* ?) sp. ind. aff. *fusiformis*, Phill.
*Martiniopsis* cf. *subpentagonalis*, Waag.
*Rhynchonella confinensis*, Schellw.
  „ cf. *Wynnei*, Waag.

The fossils of this horizon are, unfortunately, scarce, generally ill preserved, and of a rather indifferent character. For a correlation with the anthracolithic faunæ of other countries they afford but little evidence. My inference of the presence of fossiliferous strata of a lower carboniferous age in Spíti, which had been based on an identification of two *Spiriferidæ* in Stoliczka's collection with *Syringothyris cuspidata*, has not been confirmed by my recent examination of the materials collected by Hayden and A. v. Krafft.

The results of this examination are more in favour of an upper carboniferous age for the flaggy limestone of Muth. *Spirifer* cf. *Strangwaysi*, *Martiniopsis* cf. *subpentagonalis*, *Rhynchonella* cf. *Wynnei* and *Rh. confinensis* point in this direction. It is chiefly the latter species,—the only one, perhaps, to which a stratigraphical importance can be conceded,—which indicates a homotaxis with upper carboniferous strata. I regret to say that these indications are rather vague, but my materials did not admit of my conclusions being established with greater certainty.

Between the flaggy limestone (8*a*, Griesbach) and the white carboniferous quartzite the following sequence of beds has been noticed in a section north-west of Muth by A. v. Krafft (manuscript note):—

*Flaggy limestone (8a, Griesbach).*

| | ft. | in. |
|---|---|---|
| 11. Shales . . . . . . . . . . . . | 10 | ... |
| 10. Two rusty brown sandstone beds, calcareous, full of crinoids and ill-preserved brachiopods . . . . | 2 | ... |
| 9. Grey calcareous sandstone with *Spirifer Curzoni*, Dien. . | 4 | ... |
| 8. Brown sandstone . . . . . . . . . | 4 | ... |
| 7. Brown sandstone with corals and crinoids . . . . | 1 | 8 |
| 6. Brown sandstone with casts of brachiopods . . . . | 3 | 4 |
| 5. Grey quartzite . . . . . . . . . . | 4 | ... |
| 4. Thin band of shale. | | |
| 3. Calcareous sandstone with shaly partings, full of brachiopods, smooth, punctate shells, with dorsal and ventral valves separated, belonging probably to *Ambocœlia* or *Martinia* . . . . . . . . . | 7 | ... |
| 2. Brown, ferruginous quartzite . . . . . . | 2 | 4 |
| 1. Ferruginous sandstone . . . . . . . . | 9 | ... |

*White carboniferous quartzite.*

This group of beds is too poor in determinable fossils for me to say anything with regard to its faunistic features, although the presence of *Spirifer Curzoni*, which has likewise been noticed in the series of limestones and shales overlying the flaggy limestone of Muth (Hayden's sub-divisions *b* and *c*) is not adverse to the view that one single fauna prevails throughout the mighty series of rocks between the top of the white quartzite and the Fenestella beds.

From the plant-bearing shales of Thabo nothing but undeterminable plant remains have been recorded.

With regard to the correlation of the white quartzite we are perfectly in the dark. It is chiefly on the authority of Mr. Griesbach that it is considered as upper carboniferous. The possibility, however, that it is homotaxial to the mountain limestone of Europe, cannot be denied.

## VII.—SUMMARY.

The main facts arrived at in the foregoing chapters may be briefly summarised as follows :—

In the development of the permian system in the Himalayas two facies may be distinguished. These two facies differ remarkably both in their lithological and faunistic characters.

One of those facies, which is confined to a limited area north of the main sedimentary belt of the Central Himalayas, corresponds to the Tibetan series of A. v. Krafft (exotic blocks of Malla Johár, p. 145).

The Tibetan series is represented by the permian white and red limestone of Chitichun No. I and of a small number of exotic blocks in the neighbourhood of Malla Sangcha E. G., discovered by Dr. A. v. Krafft in 1900. Faunistically one single horizon only—the topmost zone of the middle Productus limestone of the Salt Range—is probably represented in the fauna of those crags. A striking faunistic resemblance is found in the Productus limestone formation of the Salt Range. The faunistic relationship between the Tibetan facies of the permian system and the Productus limestone is indeed so great that we are justified in supposing that the two areas belonged to one single, uninterrupted zoo-geographical region during the permian epoch.

In the main region of the Central Himalayas the permian system is very differently developed. In all the better known sections of the anthracolithic series there is a marked unconformity at the base of the permian strata. In Kashmir the presence of permian beds is indicated by the small fauna collected by Lydekker in the dark micaceous shales in the summit of a ridge north-west of Prongam Tral. But stratigraphical evidence to establish the correlation of the Prongam Tral beds in Kashmir with the Kuling shales of Spiti is, unfortunately, still wanting. In Spiti the permian system is more richly developed than in the adjoining districts of the eastern parts of the Central Himalayas, where it dwindles down to a thickness of only 250 feet in the Niti area.

In my memoir on the fossils of the Productus shales of Kumaon and Garhwál (Part 4 of the present volume) not more than 16 species—excluding such as were represented by mere fragments—could be enumerated as composing the permian fauna of that part of the Central Himalayas. To these, three more species from Kashmir and an equal number from the Kuling shales of Spiti have been added in my memoir on the anthracolithic fossils of Kashmir and Spiti (Part 2 of the present volume). Now this number has been considerably increased by my recent examination of the fossils described in the foregoing chapters.

The following is a complete list of the permian fossils of the Himalayan facies. Although I have not the slightest doubt that it is not exhaustive, and that future researches will probably swell the number considerably, it contains a sufficiently large number of species to exhibit clearly its faunistic peculiarities. The fauna is composed of Cephalopoda, Pelecypoda, Gasteropoda and Brachiopoda, the latter class being in the overwhelming majority, whereas Corals and Bryozoa are entirely wanting.

It contains the following species:—

### *Cephalopoda.*

1. *Orthoceras*, sp. ind.
2. *Nautilus* (*Gryposeras*), sp. ind.

3. *Xenaspis* cf. *carbonaria*, Waag.
4. *Cyclolobus* cf. *Oldhami*, Waag.
5. „ *insignis*, Dien.
6. „ (*Krafftoceras*) *Kraffti*, Dien.
7. „ „ *Haydeni*, Dien.
8. *Hyattoceras* nov. sp. ex aff. *H. Cumminsi*, White.
9. *Adrianites* (*Hoffmannia*), sp. ind.
10. *Gastrioceras* sp. ind. aff. *Marianum*, Vern.
11. *Pericyclus*, sp. ind.
12. *Lilinthiceras*, nov. gen. sp. ind.
13. *Brancoceras*, sp. ind.
14. *Nomismoceras Smithii*, Dien.

### *Lamellibranchiata.*

15. *Aviculopecten hiemalis*, Salt.
16. „ nov. sp. ind.
17. *Goniomya* sp. ind. aff. *Kasanensis*, Gein.
18. „ nov. sp. ind.
19. *Liebea* sp. ind. aff. *Hausmanni*, Goldf.
20. *Leda* cf. *speluncaria*, Gein.
21. *Oxytoma laticostatum*, Netsch.
22. *Modiolopsis Teploff*, Vern.
23. *Solemya* cf. *biarmica*, Vern.
24. *Mytilus*, sp. ind.
25. *Conocardium* sp. ind. aff. *siculo*, Gemm.
26. *Myophoriopis* (?) *Kraffti*, Dien.
27. *Megalodus*, sp. ind.

### *Gasteropoda.*

28. *Pleurotomaria* cf. *punjabica*, Waag.
29. *Naticopsis*, sp. ind.
30. *Bellerophon* cf. *Vigilii*, Stache.
31. „ sp. ind.
32. *Entalis*, sp. ind. (aff. *herculea*, de Kon.?).

### *Brachiopoda.*

33. *Chonetes Vishnu*, Salt.
34. „ *lissarensis*, Dien.
35. „ *transitionis*, Krotow.
36. „ cf. *uralica*, Mœll.
37. „ *grandicosta*, Waag.
38. *Productus gangeticus*, Dien.
39. „ *Abichi*, Waag.
40. „ cf. *serialis*, Waag.
41. „ *Purdoni*, Dav.
42. „ cf. *cancrini*, Vern.
43. „ *cancriniformis*, Tschern.
44. *Marginifera himalayensis*, Dien.
45. *Aulosteges* cf. *gigas*, Netsch.

46. *Strophomena analoga*, Phill.
47. *Spirifer rajah*, Salt.
48. „ sp. ind. aff. *rajah*, Salt.
49. „ *fasciger*, Keyserl.
50. „ *nitiensis*, Dien.
51. „ *bambadhurensis*, Dien.
52. „ *joharensis*, Dien.
53. „ *Marconi*, Waag.
54. „ *Ravana*, Dien.
55. „ *Distefanii*, Gemm.
56. *Martinia* cf. *glabra*, Mart.
57. *Spirigera* cf. *protea* var. *alata*, Abich.
58. „ *Royssii*, Lév.
59. „ *Gerardi*, Dien.
60. *Spirigerella derbyi*, Waag.
61. *Streptorhynchus* cf. *pectiniformis*, Dav.
62. *Dielasma La Touchei*, Dien.

This fauna is composed of two classes of types. The first class is represented by autochthonous species which have not been hitherto found in extra-Himalayan areas. It amounts to 31 species. This is the majority of species, if five of the specifically undetermined forms, the affinities of which are not known (Nos. 1, 27, 29, 32 of the preceding list), are excluded from the total fauna.

The second class, amounting to 26 species, which are identical with such as occur also in the younger palæozoic strata of other countries, is composed of two different groups, *viz.*, Salt Range types and European types. Seven species are absolutely, and six more probably, identical with species which have been described from the Productus limestone of the Salt Range by Waagen. With the permian rocks of Europe (Russia, Germany, Eastern Alps, Sicily) the permian strata of the Himalayan facies have 8 identical species in common, to which must be added 7 more which are probably identical.

The percentage of species identical or probably identical with Salt Range forms is comparatively small,—23·2 % only, whereas in the fauna of Chitichun No. I this percentage amounts to 49·3 % of the total fauna. The affinities of the permian fauna of the Himalayan facies to that of the Tibetan facies are still less distinctly marked, the species identical in both districts not exceeding 7. The species are—

*Xenaspis carbonaria*, Waag.
*Productus Abichi*, Waag.
„ *cancriniformis*, Tschern.
*Spirifer fasciger*, Keyserl.
*Martinia* cf. *glabra*, Mart.
*Spirigera Royssii*, Lév.
*Spirigerella derbyi*, Waag.

In both districts either the one or the other of those species is very rare.

The overwhelming majority of the chief leading fossils of the permian system in the Himalayan facies are autochthonous species, none of which has been hitherto found outside the Himalayas. The most important and widely distributed among those species are the following :—

*Chonetes Vishnu*, Salt.
„ *lissarensis*, Dien.
*Marginifera himalayensis*, Dien.
*Spirifer rajah*, Salt.
„ *nitiensis*, Dien.
*Spirigera Gerardi*, Dien.
*Dielasma La Touchei*, Dien.

Lithologically there is also a very strongly marked difference between the Himalayan and Tibetan facies, the permian system being represented in the Himalayan series by dark shales and calcareous sandstones, whereas the exotic blocks of permian age in the Tibetan facies are composed of white and red, massive limestones.

The great unconformity, which has been described by Griesbach, Hayden and Krafft within the anthracolithic rocks of the sedimentary belt of the Central Himalayas, is younger than the Fenestella shales of Spiti, which most probably correspond in age to the upper carboniferous Zewán or Barus beds of Kashmir. Thus recent evidence has confirmed my suggestion that this unconformity might be represented in Central Asia by Bogdanowitsch's "Tibetan transgression."

# APPENDIX.

## Note on *Spirifer Curzoni*, Diener. By H. H. Hayden, Geological Survey of India.

The specimens described by Professor Diener in the foregoing memoir under the name of *Spirifer Curzoni*, n. sp., were collected by the late Dr. von Krafft and by me at two localities near Muth in Spiti. At each locality they were found in a limestone series which overlies the Muth quartzite and which was regarded by Mr. Griesbach as of upper carboniferous age. Two fragmentary specimens of apparently the same species were obtained many years ago by Stoliczka from a limestone near Kuling, and were identified by Professor Diener (Pal. Ind., ser. XV, vol. III, pt. 2), on the evidence of external characters only, with *Syringothyris cuspidata*, Mart., but have now been referred by him to his new species.

Four reasons have been assigned by Professor Diener for the removal of the species from *Syringothyris cuspidata*, Mart.; they are—

(1) the absence of the internal structure characteristic of that genus;
(2) the imperforate character of the shell;
(3) the existence of acutely terminated wings;
(4) the presence of concentric laminæ intersecting the radial sculpture.

(1) Owing to the small number of specimens among our collections from Muth, Professor Diener was unwilling to sacrifice more than three in order to ascertain the nature of their internal structure, and in the sections prepared from them he was unable to trace the septa and tubular process characteristic of *Syringothyris*; he therefore inferred that the species must belong to the genus *Spirifer*. Of these three, two have been returned with his type-specimens, and a careful examination shows that they were both, unfortunately, broken and imperfect shells, in one case the part where the transverse plate and tubular process should be found, has been broken away, and in the other case the interior of the ventral valve is occupied by a small *Rhynchonella*.

During a recent visit to Spiti I was able to make larger collections from the original localities near Muth, and also from Kuling and from the hills between the Lipak and Yulang rivers in Kanaur, where the same limestones are well exposed. It was thus possible to make a large number of sections in order to ascertain definitely the internal characters of the species, and these sections showed, almost without exception, the dental septa, transverse plate and tubular process of *Syringothyris*. Owing to the apparent identity of the latter specimens with those described by Professor Diener in the foregoing memoir, I made sections of two specimens taken from amongst his named duplicates of *Spirifer Curzoni*, and found in each case the typical internal characters of *Syringothyris*. Subsequent correspondence with him on the subject has led to the publication, with his consent, of the present note, as an appendix to his memoir.

Plate X, figs. 1 and 2, are reproductions of photographs of the sections cut from Professor Diener's duplicates of *Spirifer Curzoni*; figs. 3 and 4 represent sections of specimens from the limestones of the Lipak river in Kanaur.

(2) The second reason assigned by Professor Diener for referring his specimens to the genus *Spirifer* was the absence of perforations in the shell.

After much controversy, the punctate character of *Syringothyris* was finally established by Meek and King about the middle of the last century. It was found by them that a notable feature of this perforation was its extreme irregularity, many fragments of an undoubtedly punctate shell showing no trace of perforations. A careful examination of a large number of flakes taken from the shells of Professor Diener's specimens and of others subsequently collected by me, has proved that in the Himalayan forms this "patchy" distribution of the perforations is equally pronounced; but that the shells are punctate will be seen from figures 5—8, pl. X. Figure 5 is a photograph of a flake taken from the surface of the ventral valve of Professor Diener's type-specimen of *Spirifer Curzoni*, while figs. and 7 show the perforate character of the shell of two specimens from near Lio, in Kanaur. Figure 8 is a photo-micrograph of the shell of the specimen represented in fig. 3; the degree of magnification being the same in each of the figures 5 to 8, it will be noticed that the perforations represented in fig. 8 are much larger than those of the other specimens, but there are indications of a similar series of larger tubes in the specimen shown in fig. 7, at that part of the flake where the fibres have been broken at right angles to their longer axes, and the perforations appear as long cylinders instead of as dots. In all the specimens the shell is made up of long, thin prisms, pierced, more or less at right angles to their longer axes, by the perforations.

(3) The third feature to which Professor Diener draws attention is the existence of wings in some of his specimens. He writes: "Specimens with sub-elliptical outlines are rare. In the majority of my examples the lateral margins form a convex curve to within a short distance from the cardinal angles, where they are prolonged with acute terminations." Unfortunately, the material sent to Professor Diener, as well as that subsequently collected by me, very rarely affords specimens having this part of the shell uninjured; in most cases the terminations are broken off, but I have, nevertheless, been able to find a few specimens sufficiently well preserved to show that the angle between the lateral margin and the hinge-line is exceedingly variable. Acute wings certainly occur in several instances, but other specimens show perfectly rounded terminations, and others, again, occupy positions intermediate between these two extremes. Since we have thus a series of specimens, obtained from the same bed and apparently corresponding with one another in all other respects, it is reasonable to refer them all to the same species and to regard this character as a mere variation of no specific importance. Were we, indeed, to attempt to employ the terminal angle as a means of specific distinction, we should be compelled to create a new species for almost every individual specimen of this genus to be found among our Himalayan collections. Nor could such a course be justified in the case of one particular genus of the *Spiriferidæ*, when, in so many others, no importance is attached to the variability of this feature.

Exactly similar variation was noticed by the late Dr. Bittner in the case of *Spiriferina Stracheyi*, Salter,[1] and a glance at pl. IV, figs. 3—14, of his memoir will readily exemplify the great range of variation of the terminations of the hinge-line in that species. Further examples can be found in many other species of *Spiriferidæ*, a striking one being furnished by the two dorsal valves of *Spirifer mesostrialis*, Hall, figured on pl. XXXVII, figs. 4, 5, of the "Natural History of New York,"[2] while a less pronounced example may be found in the specimens of *Spirifer Lydekkeri*, Diener, figured on pl. III of Professor Diener's "Anthracolithic fossils of Kashmir and Spiti."[3]

(4) The last peculiarity mentioned by Professor Diener is the occurrence of "concentric laminæ intersecting the radial sculpture." He states that this is observable in some specimens, but not in others.

An examination of Martin's figures of *Anomia cuspidata* shows that this feature existed in the original specimen employed as the type of the species; in his diagnosis, too, he distinctly states that the ribs are "crossed by a few slight concentric wrinkles, marking, apparently, the growth of the shell."[4]

Subsequently the same feature was noticed by Davidson, who, in his diagnosis of *Spirifera cuspidata*, Mart.,[5] mentions "numerous concentric lines of growth;" de Koninck also draws attention to the "fines striées ondulées d'accroissement."[6] The presence of "concentric laminæ" cannot therefore be employed as a means of distinction from *Syringothyris cuspidata*, Mart.

---

[1] Pal. Ind., ser. XV, vol. III, pt. 2, pp. 18, 19.

[2] Palæontology, vol. VIII, Brachiopoda, II.

[3] Pal. Ind., ser. XV, vol. I, pt. 2, pl. IV, figs. 3, 5, 7, 8, 9, 11.

[4] Trans. Linnean Society, vol. IV, 1798, p. 45, and tab. 3. figs. 1—4, tab. 4, figs. 5, 6.

[5] Davidson: Fossil Brachiopoda. vol. IV, p. 44.

[6] Description des Animaux fossiles, 1842—1844, p. 241.

It seems to me, therefore, that no sufficient cause has been shown for removing the Himalayan species described by Professor Diener as *Spirifer Curzoni*, n. sp., from *Syringothyris cuspidata*, Mart., to which it bears so close a resemblance.[1]

Owing to the small number and poor state of preservation of the fossils sent to Professor Diener, he was doubtful as to the age of the limestone in which the above species of *Syringothyris* occurs. In his memoir on the "Anthracolithic fossils of Kashmir and Spiti,"[2] he drew attention to the specimen described by him as *Syringothyris cuspidata*, Mart., from Kuling, and correctly inferred that the bed in which it occurred was of lower carboniferous age; at the same time he suggested that this bed might be the equivalent of Griesbach's "lower carboniferous *grey crinoid limestone*." During my survey of Spiti, however, I ascertained that these two horizons were not identical, but that one lay above, and the other below, the Muth quartzite; and since Stoliczka's specimen was too poorly preserved and too fragmentary to admit of definite specific identification, it seemed that there were not sufficient grounds for removing this limestone series from the upper carboniferous system, in which it had been placed by Griesbach.[3] Subsequent examination, however, of my more recent collections from the Lipak river sections has proved that Professor Diener was undoubtedly correct in his original assumption of a lower carboniferous age for the limestone, which has been found to contain, in addition to *Syringothyris*, *Helodus crenulatus*, Newberry and Worthen, a trilobite closely resembling *Phillipsia Cliffordi*, Woodward, and other lower carboniferous forms, while a bed considerably higher in the series yielded a species of *Euomphalus* indistinguishable from *E. hecale*, Hall, from the devonian of New York. Still more recently, I have been informed by Professor Zeiller that certain plants, which were found in a band of shale, situated at least 1,000 feet above the *Syringothyris* horizon, include many specimens of *Rhacopteris inæquilatera*, Feistmantel, a species found in the Culm of New South Wales. There is consequently little doubt that the limestone is not younger than lower carboniferous.[4]

In the present memoir Professor Diener has not assigned any definite age to the limestone of Muth, though, on account of the presence of *Rhynchonella confinensis*, Schellwien, and other species related to upper carboniferous forms, he was inclined to regard it as younger than he had previously supposed. Since, however, I have been able to show him photographs of the sections of his *Spirifer Curzoni*, he now agrees with me in referring that species to the genus *Syringothyris*, and has stated in a letter, of which he has kindly allowed me to make use in the present note, that should the balance of evidence be in favour of a lower carboniferous age for the limestone, no great weight should be attached to the presence of *Rhynchonella confinensis*, which has hitherto been found in one locality only and may therefore subsequently prove to have a wider range than it is at present known to possess.

---

[1] Professor Diener, to whom the above notes have been submitted for comment, informs me that the late Dr. Bittner, in spite of his insistence on the wide range of variation to be found in the shape of the wings of single species of *Spiriferidæ*, urged him to separate the forms now under discussion from *Syringothyris cuspidata*, Mart., on account of the presence of acute wings and concentric laminæ in the Indian specimens. Professor Diener would therefore prefer to retain his specific name of *Syringothyris Curzoni* for those forms with acute terminations and with pronounced concentric lines of growth, the remaining forms, in which these characteristics are less marked, being allowed to stand with *S. cuspidata*, Mart. Should this classification be finally adopted, it is probable that some difficulty will be experienced in dealing with intermediate forms, but this question must remain in abeyance till the Spiti collections have been completely worked out and described.

[2] Pal. Ind., ser. XV, vol. I, pt. 2.

[3] Annual Report, G. S. I., 1899-1900, p. 188.

[4] This question has been more fully discussed in a memoir on the geology of Spiti, at present in process of publication.

# PLATE III.

Permian fossils from the exotic block No. 9 in the neighbourhood of Malla Sangcha, E.G.
(Coll. A. v. Krafft.)

Fig. 1; 2 *a*, *b*. Lima sp. ind. aff. retifera, Shumard. 1, right valve. 2, left valve.

Fig. 3 *a*, *b*. Naticopsis khurensis, Waag.

Fig. 4 *a*, *b*. Bellerophon sp. ind. aff. polito, Waag.

Fig. 5 *a—d*. Pleurotomaria (Mourlonia) hunica, nov. sp. 5*d*, sculpture of the last volution enlarged.

Fig. 6 *a—d*; 7 *a*, *b*. Orthothetes Kraffti, nov. sp.

Fig. 8 *a*, *b*. Productus chitichunensis, Dien. Ventral valve with its trail partly preserved.

Fig. 9 *a—d*. Marginifera helica, Abich.

Fig. 10 *a*, *b*. Scacchinella (?), sp. ind.

Fig. 11. Spiriferina cf. octoplicata var. fastigata, Schellwien.

Fig. 12 *a—d*. Rhynchonella sp. ind. ex aff. Rh. Hofmanni, Krotow.

Fig. 13 *a—d*. Notothyris minuta, Waag.

Fig. 14 *a—d*. Notothyris mediterranea, Gemm.

Fig. 15 *a—d*. Notothyris cf. Walkeri, Dien.

Fig. 16 *a—d*. Notothyris ovalis, Gemm.

Fig. 17 *a—c*. Productus plano-hæmisphærium, Netschajew. Ventral valve.

Fig. 18 *a*, *b*. Spirigerella Derbyi, Waag.

Fig. 19 *a—d*. Enteletes elegans, Gemm.

Fig. 20. Reticularia (Squamularia) cf. Dieneri, Gemm. Ventral valve with the uppermost layer of the shelly substance partly preserved.

Fig. 21 *a*, *b*. Spirifer sp. ind. ex aff S. Marcoui, Waag.

Fig. 22 *a—d*. Martinia acutomarginalis, Diener (= M. semiramis, Gemm.).

Fig. 23 *a—c*. Productus gratiosus, Waag. Exceptional shape, with unusually deep sinus.

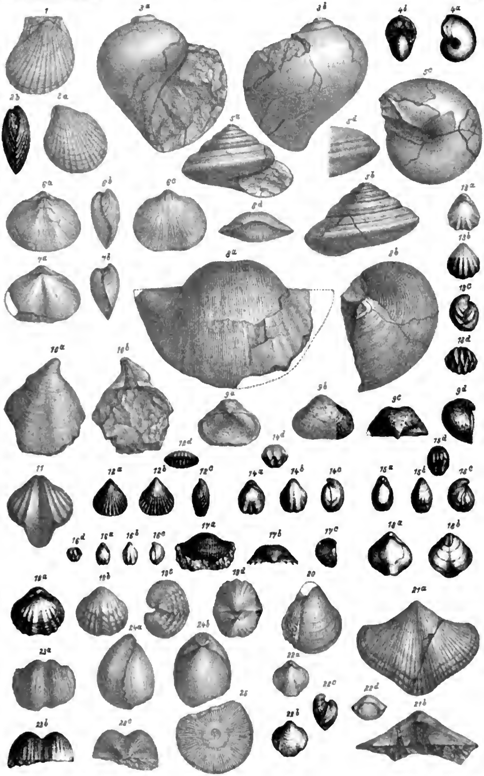
Fig. 24 *a*, *b*. Hemiptychina cf. inflata, Waag.

Fig. 25. Poteriocrinus (?), sp. ind.

DIENER: PERMIAN FOSSILS
CENTRAL HIMALAYAS.

Geol. Surv. of India.

Pl. III.



A. Swoboda del. et lith.

Albert Berger print.

# PLATE IV.

PERMIAN FOSSILS FROM THE PRODUCTUS SHALES OF THE LISSAR VALLEY (JOHAR).
(Coll. La Touche.)

Fig. 1. NATICOPSIS, sp. ind. Near crest of ridge between Lissar and Dharma Valleys, opposite Kharsa glacier.

Fig. 2 *a*, *b*. BELLEROPHON, sp. ind. Slopes on left bank of Lissar Valley, 2 miles south of Dharma XI.

Fig. 3—5. SPIRIFER RAJAH, Salter. Exceptional shapes of ventral valves. 3 and 4, from slopes on left bank of Lissar Valley; 5, near crest of ridge between Lissar and Dharma Valleys, opposite Kharsa glacier.

Fig. 6 *a*, *b*; 7 *a*, *b*. SPIRIFER NITIENSIS, Diener. Slopes on left bank of Lissar Valley, 2 miles south of Dharma XI.

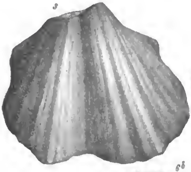
Fig. 8—10. SPIRIFER BAMBADHURENSIS, nov. sp. Right side of Bambadhura N. glacier near crossing. 8, Ventral valve. 9, Fragment of two valves. 10, Dorsal valve. *a*, Ventral view. *b*, Dorsal view.

DIENER: PERMIAN FOSSILS
CENTRAL HIMALAYAS.

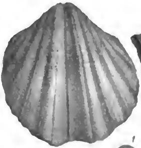
Geol. Surv. of India.

Pl. IV.

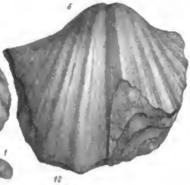
3



4

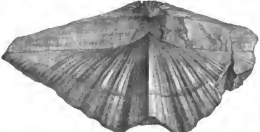


5

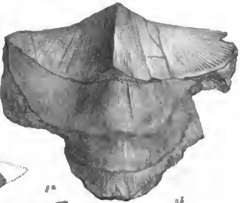


1

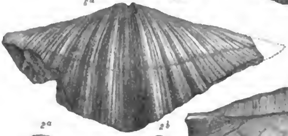
6b



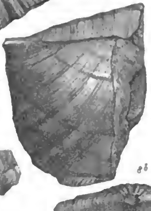
10



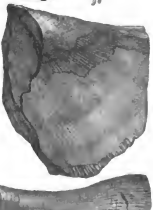
6a



9a



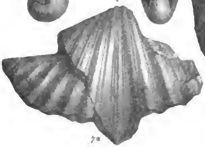
9b



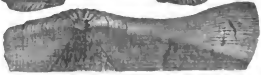
2a

2b

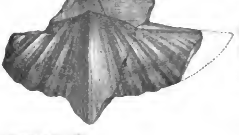
7b



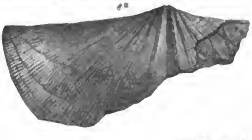
8b



7a



8a



A. Swoboda del. et lith.

Albert Berger print.

UNIV. OF MICH.

## PLATE V.

PERMIAN FOSSILS FROM THE PRODUCTUS SHALES OF THE LISSAR VALLEY (Coll. La Touche) AND OF BYANS (Coll. Smith).

Fig. 1—3. PLEUROTOMARIA cf. PUNJABICA, Waag. Slopes on left bank of Lissar Valley, 2 miles south of Dharma XI.

Fig. 4 *a*, *b*. CHONETES cf. URALICA, Mœller. Crest between Lissar and Dharma Valleys, opposite Kharsa glacier.

Fig. 5 *a*, *b*; 6 *a*, *b*. MARGINIFERA HIMALAYENSIS, Dien. Two exceptional shapes of ventral valves with strong ribs.

Fig. 7 *a*—*d*; 8 *a*—*e*; 9. DIELASMA LA TOUCHEI, nov. sp.

Fig. 10, 11. SPIRIGERA GERARDI, Dien.

Fig. 12. SPIRIFER JOHARENSIS, Dien. All these specimens (figs. 5—12) from slopes on left bank of Lissar Valley, 2 miles south of Dharma XI.

Fig. 13 *a*—*c*. LEDA cf. SPELUNCARIA, Geinitz. Nihal.

Fig. 14—17. CHONETES TRANSITIONIS, Krotow, Kalapani. 14, 15, Ventral valves. 16, Dorsal valve. 17, Cross-section of two valves.

Fig. 18 *a*, *b*. LIEBEA sp. ex aff. L. HAUSMANNI, Goldf., Kalapani.

Fig. 19. GONIOMYA, sp. ind. Kalapani.

Fig. 20 *a*—*c*. HYATTOCERAS sp. ind. ex aff. CUMMINSI, White.

Fig. 21 *a*, *b*. PERICYCLUS, sp. ind.

Fig. 22 *a*, *b*. LILINTHICERAS, nov. gen. sp. ind.

Fig. 23 *a*—*c*. GASTRIOCERAS, sp. ind. ex aff. G. MARIANUM, Verneuil.

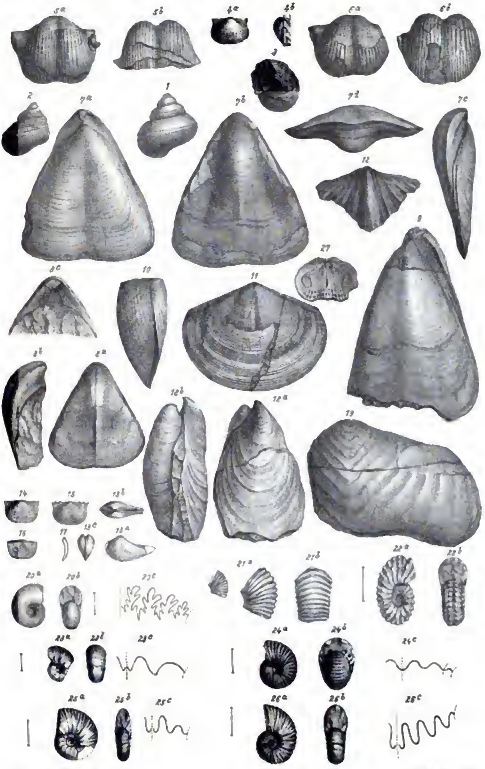
Fig. 24 *a*, *b*. BRANCOCERAS (?), sp. ind.

Fig. 25 *a*—*c*. NOMISMOCERAS SMITHII, nov. sp.

Fig. 26 *a*—*c*. ADRIANITES (HOFFMANNIA), sp. ind. All these specimens (figs. 20—26), 1 mile north-west of Lilinthi, considerably enlarged

Fig. 27. MARGINIFERA HIMALAYENSIS, Dien. Internal view of the dorsal valve, Kalapani.

Geol. Surv. of India. DIENER: PERMIAN FOSSILS CENTRAL HIMALAYAS. Pl. V.



A. Swoboda del. et lith. Albert Berger print.

# PLATE VII.

Carboniferous fossils from the lower division of the Anthracolithic system in Spiti.
(Coll. Krafft and Hayden.)

Fig. 1 *a—c*. Productus lineatus, Waag. North-west of Muth, flaggy limestone (8*a*, Griesbach) (coll. Krafft).

Fig. 2 *a—c*. Spirifer Curzoni, nov. sp. Ventral valve.

Fig. 3 *a*, *b*; 4. Spirifer Curzoni, nov. sp. Dorsal valve.

Fig. 5 *a*, *b*; 6. Spirifer Curzoni, nov. sp. Cross-sections through the apical region of two ventral valves, showing the dental plates and the absence of the tubiform process of *Syringothyris*.

Fig. 7. Spirifer sp. ind. ex aff. S. Curzoni. All these specimens from the flaggy limestone (8 *a*, Griesbach), west of Muth (coll. Hayden and Krafft).

Fig. 8 *a*, *b*. Spirifer cf. Strangwaysi, Verneuil. Flaggy limestone (8*a*, Griesbach), south-east of Muth (coll. Hayden and Krafft).

Fig. 9 *a*, *b*. Rhynchonella confinensis, Schellwien. Flaggy limestone (8*a*, Griesbach), north-west of Muth (coll. Krafft).

Fig. 10 *a—d*. Rhynchonella cf. Wynnei, Waag. From the same locality (coll. Krafft).

Fig. 11 *a*, *b*. Martiniopsis of. subpentagonalis, Waag.

Fig. 12 *a—d*. Ambocœlia (?) aff. fusiformi, Phill. These two specimens from the flaggy limestone (8*a*, Griesbach), south-east of Muth (coll. Krafft).

Fig. 13 *a—d*. Derbyia cf. senilis, Phill.

Fig. 14 *a—d*. Spirigera cf. Royssii, Lév. These two specimens from the flaggy limestone (8*a*, Griesbach), north-west of Muth (coll. Hayden and Krafft).

Fig. 15; 16 *a*, *b*; 17 *a*, *b*. Productus scabriculus, Mart. Fenestella beds, Losar Nullah (coll. Krafft and Hayden).

Fig. 18; 19 *a*, *b*; 20. Productus nystianus var. lopingensis, Keyser. Fenestella beds, Po (coll. Hayden and Krafft). 20, Specimen with the impressions of its spines preserved.

Fig. 21 *a—d*. Camarophoria sp. ind. (aff. C. acuminata, Gemm.?). Losar Nullah, Fenestella beds (coll. Hayden and Krafft).

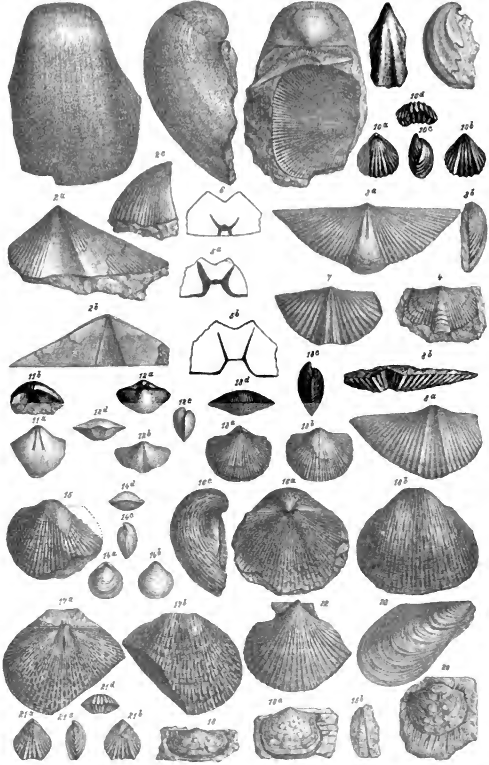
Fig. 22. Aviculopecten sp. ind. aff. hiemali, Salt.

Fig. 23. Myalina sp. ind. ex aff. recurvirostri, Meek et Worth. These two specimens from the Fenestella beds of the Losar Nullah (coll. Hayden and Krafft).

Geol. Surv. of India.

DIENER: PERMIAN FOSSILS
CENTRAL HIMALAYAS.

Pl. VII.



A. Swoboda del. et lith.

Albert Berger print.

# PLATE VIII.

## Permian fossils of the Kuling series of Spiti.

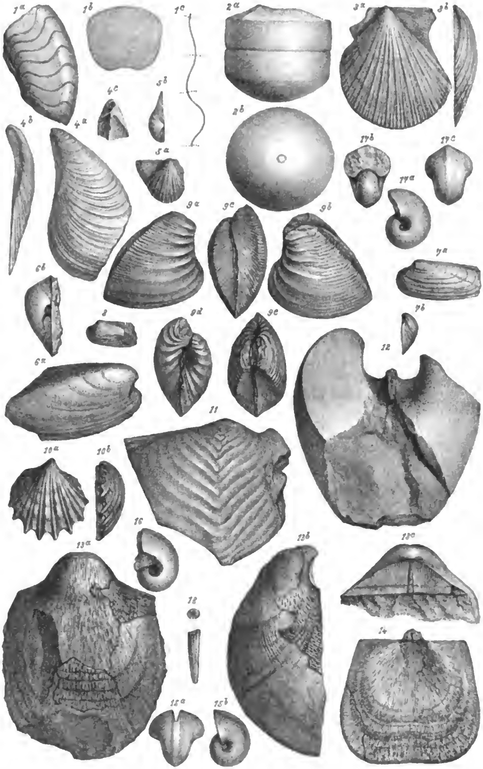
(Coll. Hayden and Krafft.)

| | |
|---|---|
| Fig. 1 *a—c*. | Nautilus (Grypoceras), sp. ind. Kuling shales, north of Po (coll. Krafft). |
| Fig. 2 *a, b*. | Orthoceras, sp. ind. Kuling shales, north-west of Muth (coll. Krafft). |
| Fig. 3 *a, b*. | Aviculopecten, sp. ind. Sandstones underlying Kuling shales, north of Po (coll. Hayden). |
| Fig. 4 *a, b*. | Mytilus, sp. ind. Kuling shales, Lilang (coll. Krafft). |
| Fig. 5 *a, b*. | Conocardium, sp. ind. aff. siculo, Gemm. Kuling shales, south of Pomarang (coll. Krafft). |
| Fig. 6 *a, b*. | Modiolopsis TeploFi, Verneuil. Kuling shales, south of Pomarang (coll. Krafft). |
| Fig. 7 *a, b*; 8. | Solemya biarmica, Verneuil. 7, Cast of left valve. 8, Cast of left valve with partly preserved shell. Kuling shales, south of Pomarang (coll. Krafft). |
| Fig. 9 *a—c*. | Myophoriopis (?) Kraffti, nov. sp. Kuling shales, nullah opposite Gaichund (coll. Krafft). |
| Fig. 10 *a, b*. | Oxytoma lævicostatum, Netsch. Sandstone underlying Kuling shales, north of Po (coll. Hayden). |
| Fig. 11. | Goniomya sp. ind. (aff. Kasanensis, Gein.). Kuling shales, Kuling (coll. Hayden and Krafft). |
| Fig. 12. | Megalodus, sp. ind. Kuling shales, Kuling (coll. Hayden and Krafft). |
| Fig. 13 *a—c*; 14. | Aulosteges cf. gigas, Netsch. 13, Ventral valve. 14, Dorsal valve. Sandstone underlying Kuling shales, north of Po (coll. Hayden and Krafft). |
| Fig. 15 *a, b*; 16. | Bellerophon cf. Vigilii, Stache. Kuling shales, south of Pomarang (coll. Krafft). |
| Fig. 17 *a—c*. | Bellerophon vigilii, Stache. Type-specimen (cast) from the permian Bellerophon Kalk of St. Vigil (Tirol). |
| Fig. 18 *a, b*. | Entalis, sp. ind. Kuling shales, south of Pomarang (coll. Krafft) |

Geol. Surv. of India.

DIENER: PERMIAN FOSSILS
CENTRAL HIMALAYAS.

Pl. VIII.



A. Swoboda del. et lith.

Albert Berger print.

## PLATE IX.

PERMIAN BRACHIOPODA OF THE KULING SERIES OF SPITI.
(Coll. Krafft and Hayden.)

Fig. 1 *a—d*. SPIRIFER MARCOUI, Waag. Sandstone underlying Kuling shales, north of Po (coll. Hayden and Krafft).

Fig. 2 *a*, *b*; 3 *a—d*. SPIRIFER DISTEFANII, Gemm. North of Po.

Fig. 4 *a—d*. SPIRIFER DISTEFANII, Gemm. Exceptional shape. Half-way between Po and Mani, left bank of Spiti River above Dankhar.

Fig. 5 *a—d*. SPIRIGERA cf. PROTEA var. ALATA, Abich. Black Kuling shales, north-west of Muth.

Fig. 6. SPIRIGERA GERARDI, Dien. Dorsal valve with expansions, north above Po.

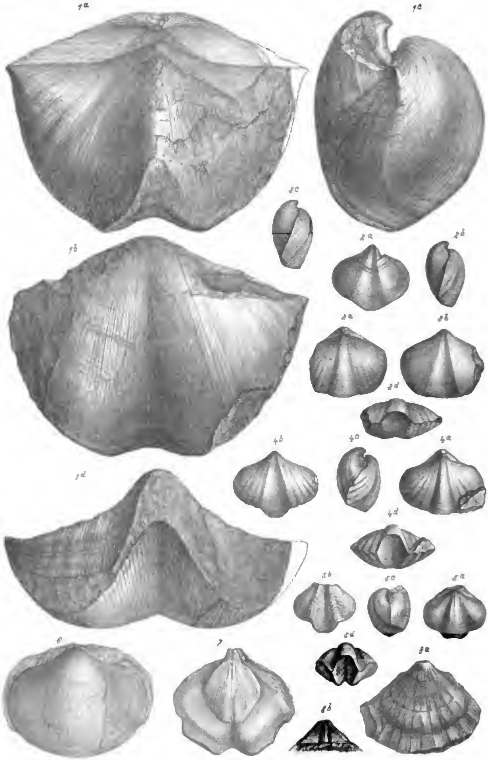
Fig. 7. SPIRIGERA GERARDI, Dien. Internal cast of ventral valve from Larsa E.G., Thanam Valley.

Fig. 8 *a*, *b*. STREPTORHYNCHUS cf. PECTINIFORMIS, Dav. Fragment of a ventral valve, north of Po. All specimens, with the exception of fig. 5, from the sandstones underlying the black Kuling shales.

Geol. Surv. of India.

DIENER: PERMIAN FOSSILS
CENTRAL HIMALAYAS.

Pl. IX.



A. Swoboda del et lith

Albert Berger print.

## PLATE X.

### SPIRIFER CURZONI, Diener.

Fig 1, 2. Photographs, by reflected light, of sections of two of Professer Diener's named duplicates of his *Spirifer Curzoni*, n. sp., showing the dental plates, transverse plate and tubular process, characteristic of *Syringothyris*; specimens from near Muth, Spiti.

Fig. 3, 4. Photographs, by transmitted light, of sections of two specimens of *Syringothyris* cf. *cuspidata*, Mart., showing dental plates, transverse plate and tubular process; from the carboniferous limestone of the Lipak river, Kanaur.

Fig. 5. Photomicrograph of fragment of shell of Professer Diener's type-specimen of *Spirifer Curzoni*, n. sp. (figured on Pl. VII, fig. 2), showing punctate character of the shell (× 20.)

Fig. 6, 7. Photomicrographs of fragments of shell of specimens of *Syringothyris* cf. *cuspidata*, Mart., from the limestone of the Lipak river, showing punctate character of shell (× 20.)

Fig. 8. Photomicrograph of part of shell of specimen represented in fig. 3. The section, which is cut at right angles to the surface of the shell, shows tubular perforations running through the shell, and occasionally dichotomising ( × 20).

# DIENER: PERMIAN FOSSILS
# CENTRAL HIMALAYAS.

Geological Survey of India.

PLATE X.

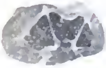


Fig. 1.

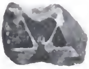


Fig. 2.

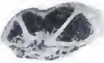


Fig. 3.

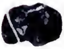


Fig. 4.

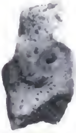


Fig. 6.
× 20.

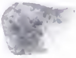


Fig. 5.
× 20.

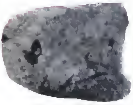


Fig. 7
× 20

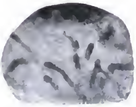


Fig. 8.
× 20.

UNIV. OF

H. H. Hayden, photo.

Photogravure, Survey of India Offices, Calcutta, August 1903

# RECORDS OF THE GEOLOGICAL SURVEY OF INDIA.

Vols. I to XXX, 1868 to 1897.

The price fixed for these publications is 1 rupee each part, or 2 rupees each volume.

# PALÆONTOLOGIA INDICA.

(Series I, III, V, VI, VIII.)

## CRETACEOUS FAUNA OF SOUTHERN INDIA, *by* F. STOLICZKA, *except* Vol. I, Pt. 1, *by* H. F. BLANFORD.

Ser. I & III.—Vol. I. The Cephalopoda (1861—65), pp. 216, pls. 94 (6 double).
„ II. The Gastropoda (1867—68), pp. xiii, 500, pls. 28.
„ III. The Pelecypoda (1870—71), pp. xxii, 537, pls. 50.
„ IV. The Brachiopoda, Ciliopoda, Echinodermata, Corals, etc. (1872—73), pp. v, 202, pls. 29.

(Series II, XI, XII.)

## THE FOSSIL FLORA OF THE GONDWANA SYSTEM, *by* O. FEISTMANTEL, *except* Vol. I, Pt. 1, *by* T. OLDHAM *and* J. MORRIS.

Vol. I, pp. xviii, 233, pls. 72. 1863—79. Pt. 1; Rájmahál Group, Rájmahál Hills. Pt. 2; *The same (continued)*. Pt. 3; Plants from Golapilli. Pt. 4; Outliers on the Madras Coast.
„ II, pp. xli, 115, pls. 26. 1876—78. Pt. 1; Jurassic Flora of Kach. Pt. 2; Flora of the Jabalpur Group.
„ III, pp. xi, 64 + 149, pls. 80 (9 double) (I—XXXI + IA—XLVIIA). 1879—81. Pt. 1; The Flora of the Talchir-Karharbari beds. Pt. 2; The Flora of the Damuda and Panchet Divisions. Pt. 3; *The same (concluded)*.
„ IV, pp. xxvi, 25 + 66, pls. 35 (2 double) (I—XXV + IA—XIVA). Pt. 1 (1882); Fossil Flora of the South Rewah Gondwana basin. Pt. 2 (1886); Fossil Flora of some of the Coal-fields in Western Bengal.

(Series IX.)

## JURASSIC FAUNA OF KACH.

Vol. I (1873—76). The Cephalopoda, by W. Waagen, pp. i, 247, pls. 60 (6 double).
„ II, pt. 1 (1893). The Echinoidea of Kach, by J. W. Gregory, pp. 12, pls. 2.
„ „ „ 2 (1900). The Corals, by J. W. Gregory, pp. 196, I—IX, pls. 26.
„ III „ 1 (1900). The Brachiopoda, by F. L. Kitchin, pp. 87, pls. 1—15.
„ „ „ 2, No. 1 (1903). Lamellibranchiata, Genus Trigonia, by F. L. Kitchin, pp. 122, pls. 1—10.

(Series IV.)

## INDIAN PRE-TERTIARY VERTEBRATA.

Vol. I, pp. vi, 137, pls. 26. 1865—85. Pt. 1 (1865); The Vertebrate Fossils from the Panchet rocks, by T. H. Huxley. Pt. 2 (1878); The Vertebrate Fossils of the Kota-Maleri Group, by Sir P. de M. Grey Egerton and L. C. Miall. Pt. 3 (1879); Reptilia and Batrachia, by R. Lydekker. Pt. 4 (1885); The Labyrinthodont from the Bijori Group, by R. Lydekker. Pt. 5 (1885); The Reptilia and Amphibia of the Maleri and Denwa groups, by R. Lydekker.

(Series X.)

## INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA, *by* R. LYDEKKER, *except* Vol. I, Pt. 1, *by* R. B. FOOTE.

Vol. I, pp. xxx, 300, pls. 50. 1874—80. Pt. 1; Rhinoceros deccanensis. Pt. 2; Molar teeth and other remains of Mammalia. Pt. 3; Crania of Ruminants. Pt. 4; Supplement to Pt. 3. Pt. 5; Siwalik and Narbada Proboscidia.
„ II, pp. xv, 363, pls. 45. 1881—84. Pt. 1; Siwalik Rhinocerotidæ. Pt. 2; Supplement to Siwalik and Narbada Proboscidia. Pt. 3; Siwalik and Narbada Equidæ. Pt. 4; Siwalik Camelopardalidæ. Pt. 5; Siwalik Selenodont Suina, etc. Pt. 6; Siwalik and Narbada Carnivora.
„ III, pp. xxiv, 264, pls. 38. 1884—86. Pt. 1; Additional Siwalik Perissodactyla and Proboscidia. Pt. 2; Siwalik and Narbada Bunodont Suina. Pt. 3; Rodents and new Ruminants from the Siwaliks. Pt. 4; Siwalik Birds. Pt. 5; Mastodon Teeth from Perim Island. Pt. 6; Siwalik and Narbada Chelonia. Pt. 7; Siwalik Crocodilia, Lacertilia and Ophidia. Pt. 8; Tertiary Fishes.
„ IV, pt. 1, 1886. Siwalik Mammalia (Supplement 1), pp. 18, pls. 6.
„ „ „ 2, 1886. The Fauna of the Karnul caves (and addendum to Pt. 1); pp. 40 (19—58), pls. 5 (vii—xi).
„ „ „ 3, 1887. Eocene Chelonia from the Salt Range; pp. 7 (59—65), pls. 2 (xii—xiii).

(Series XIII.)

## SALT-RANGE FOSSILS, *by* WILLIAM WAAGEN, Ph.D.

Productus-Limestone Group: Vol. I, Pt. 1 (1879). Pisces, Cephalopoda, pp. 72, pls. 6.
„ „ „ „ 2 (1880). Gastropoda and Supplement to Pt. 1, pp. 111 (73—183), pls. 10 (1 double). (vii—xvi).
„ „ „ „ 3 (1881). Pelecypoda, pp. 144 (185—328), pls. 8 (xvii—xxiv).
„ „ „ „ 4 (1882—85). Brachiopoda, pp. 442 (329—770), pls. 62 (xxv—lxxxvi).
„ „ „ „ 5 (1885). Bryozoa—Annelidæ—Echinodermata, pp. 64 (771—834), pls. 10 (lxxxvii—xcvi).
„ „ „ „ 6 (1886). Cœlenterata, pp. 90 (835—924), pls. 20 (xcvii—cxvi).
„ „ „ „ 7 (1887). Cœlenterata, Protozoa, pp. 74 (925—998), pls. 12 (cxvii—cxxviii).
Fossils from the Ceratite Formation: Vol. II, Pt. 1 (1895). Pisces—Ammonoidea, pp. 324, pls. 40.
Geological Results: Vol. IV, Pt. 1 (1889), pp. 1—88, pls. 4.
„ „ „ „ 2 (1891), pp. 89—242, pls. 8.

(Series VII, XIV.)

## TERTIARY AND UPPER CRETACEOUS FAUNA OF WESTERN INDIA, *by* P. MARTIN DUNCAN *and* W. PERCY SLADEN, *except* Pt. 1, *by* F. STOLICZKA.

Vol. I, pp. 16 + 110 + 382 + 91 = 599, pls. 5 + 28 + 58 + 13 = 104. 1871—85. Pt. 1; Tertiary Crabs from Sind and Kach. Pt. 1 (new 2); Sind Fossil Corals and Alcyonaria. Pt. 3; The Fossil Echinoidea of Sind: *Fas. 1.* The *Cardita beaumonti* beds; *Fas. 2.* The Ranikot series in Western Sind; *Fas. 3.* The Kirthar Series; *Fas. 4.* The Nari (Oligocene) Series; *Fas. 5.* The Gaj (Miocene) Series; *Fas. 6.* The Makrán (Pliocene) Series. Pt. 4; The Fossil Echinoidea of Kach and Kattywar.

(Series XV.)

## HIMALAYAN FOSSILS.

The Anthracolithic Fossils of Kashmir and Spiti: Vol. I, Pt. 2 (1899), pp. 95, pls. 8. By C. Diener.
The Permo-carboniferous Fauna of Chitichun No. I: Vol I: Pt. 3 (1897), pp. 105, pls. 13. By C. Diener.

# PALÆONTOLOGIA INDICA—*continued.*

The Permian Fossils of the Productus Shales of Kumaon and Garhwál. Vol. I, Pt. 4 (1897), pp. 54, pls. 5. By C. Diener.
The Permian Fossils of the Central Himalayas. Vol. I, Pt. 5, pp. 204, pls. X. By C. Diener.
The Cephalopoda of the Lower Trias. Vol. II, Pt. 1 (1897), pp. 182, pls. 23 }
The Cephalopoda of the Muschelkalk. Vol. II, Pt. 2 (1895), pp. 118, pls. 31. } By C. Diener.
Upper Triassic Cephalopoda Fauna of the Himálayas, by Edmund von Mojsisovics. Vol. III, Pt. 1 (1899), pp. 158, pls. 2.
Trias Brachiopoda and Lamellibranchiata, by Alexander Bittner. Vol. III, Pt. 2 (1899), pp. 76, pls. 12 (1 double).
Fauna of the Spiti Shales. Vol. IV, 1903, by V. Uhlig.

---

(Series XVI.)

BALUCHISTAN FOSSILS, *by* FRITZ NOETLING, PH.D., F.G.S.

The Fauna of the Kellaways of Mazár Drik. Vol. I, Pt. 1 (1895), pp. 22, pls. 13.
The Fauna of the (Neocomian) Belemnite Beds. Vol. I, Pt. 2 (1897), pp. 5, pls. 2.
The Fauna of the Upper Cretaceous (Maëstrichtian) Beds of the Mari Hills. Vol. I, Pt. 3 (1897), pp. 79, pls. 23.

---

(New Series.)

Vol. I, Pt. 1 (1899), pp. 14, pl. 1. The Cambrian Fauna of the Eastern Salt Range, by K. Redlich, Ph.D.
" I, " 2 (1899), pp. 58, pls 4. Notes on the Morphology of the Pelecypoda, by Fritz Noetling, Ph.D., F.G.S.
" I, " 3 (1901), pp. 378, pls. 25. Fauna of the Miocene Beds of Burma, by Fritz Noetling, Ph.D., F.G.S.
" II, " 1 (1902), pp. 39, pls. 7. Observations sur quelques Plantes Fossiles des Lower Gondwanas, by R. Zeiller.

---

**The price fixed for these publications is 4 annas (4 pence) per single plate.**

---

# MISCELLANEOUS PUBLICATIONS.

A Manual of the Geology of India. 4 Vols. With map. 1879—1887—
  Vol. 1. Peninsular Area. }
  Vol. 2. Extra-Peninsular Area. } By H. B. Medlicott and W. T. Blanford. Price 8 rupees. (*Out of print.*)
  Vol. 3. Economic Geology. By V. Ball. Price 5 rupees. (*Out of print.*)
  Vol. 4. Mineralogy. By F. R. Mallet. Price 2 rupees.
A Manual of the Geology of India, 2nd edition. By R. D. Oldham (1893). Price 8 rupees.
A Manual of the Geology of India, Economic Geology, by the late Prof. V. Ball, 2nd edition, revised in parts.
  Part I.—Corundum. By T. H. Holland (1898). Price 1 rupee.
Popular guides to the geological collections in the Indian Museum, Calcutta—
  No. 1. Tertiary vertebrate animals. By R. Lydekker. 1879. Price 2 annas. (*Out of print.*)
  No. 2. Minerals. By F. R. Mallet (1879). Price 2 annas. (*Out of print.*)
  No. 3. Meteorites. By F. Fedden (1880). Price 2 annas. (*Out of print.*)
  No. 4. Palæontological collections. By O. Feistmantel (1881). Price 2 annas.
  No. 5. Economic mineral products. By F. R. Mallet (1883). Price 2 annas. (*Out of print.*)

An Introduction of the Chemical and Physical study of Indian Minerals. By T. H. Holland (1895). Price 8 annas. (*Out of print.*)

Catalogue of the remains of Siwalik Vertebrata contained in the Geological Department of the Indian Museum. By R. Lydekker, Pt. I. Mammalia (1885). Price 1 rupee. Pt. II. Aves, Reptilia, and Pisces (1886). Price 4 annas.

Catalogue of the remains of Pleistocene and Pre-Historic Vertebrata contained in the Geological Department of the Indian Museum. By R. Lydekker (1886). Price 4 annas.

Bibliography of Indian Geology. By R. D. Oldham (1888). Price 1 rupee 8 annas.

Report on the Geological Structure and Stability of the Hill slopes around Naini Tal. By T. H. Holland (1897). Price 3 rupees.

Geological map of India, 1893. Scale 1" = 96 miles. Price 1 rupee.

General Report for the period from the 1st April 1901 to the 31st March 1902. Price 1 rupee.
Do. do. do. 1902 do. do. 1903. do.

---

# GEOLOGICAL SURVEY OF INDIA.

*Director.*
T. H. Holland, A.R.C.S., F.G.S.

*Superintendents.*
R. D. Oldham, A.R.S.M., F.G.S.; Tom D. La Touche, B.A. (Cantab.), F.G.S.;
C. S. Middlemiss, B.A. (Cantab), F.G.S.

*Deputy Superintendents.*
P. N. Bose, B.Sc. (London), F.G.S.; P. N. Datta, B.Sc. (London), F.G.S.;
F. H. Smith, A.R.C.S., F.G.S.; H. H. Hayden, B.A., B.E., F.G.S.

*Assistant Superintendents.*
E. Vredenburg, B.L., B.Sc. (Paris), A.R.C.S.;
L. Leigh Fermor, A.R.S.M., F.G.S.
Guy E. Pilgrim, B.Sc. (London).
G. H. Tipper, B.A. (Cantab.).

*Specialists.*
R. R. Simpson, B.Sc. (Dunelm);
J. Malcolm Maclaren, B.Sc. (New Zealand), F.G.S.

*Sub-Assistants.*
Hira Lal;

*Artist.*
H. B. W. Garrick.

*Assistant Curator.*
T. R. Blyth.

*Registrar.*
A. E. Macaulay Audsley.

---

Geological Museum, Library, and Office, Calcutta.

UNIVERSITY OF MICHIGAN
3 9015 06198 9656